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The Nisqually Watershed From the Summit to the Sound: A Field Guide

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THE NISQUALLY WATERSHED

From the Summit…

A FIELD GUIDE

…to the Sound

Portland State University
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THE NISQUALLY WATERSHED

From the Summit to the Sound

A FIELD GUIDE

By:

Rebecca D. Hixson,
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and

Teresa L. Bulman,
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This guide was made possible because of ...

...the individuals and groups that have worked extremely hard over many years to preserve this area and create materials which educate the community on the importance of keeping the Nisqually Watershed in excellent condition.

THE NISQUALLY WATERSHED

From the Summit to the Sound

CONTENTS

THE NISQUALLY WATERSHED

From the Summit to the Sound

FOREWORD

This guide begins at the summit of Mount Rainier and, like a drop of water, descends toward the sea. It provides information about geological, hydrological, geographical, biological and historical aspects of the Nisqually watershed. It describes the natural resources in the area and identifies how the use of those resources affects water quality and quantity.

Since the weather is variable in the Pacific Northwest, be sure to bring appropriate clothing and supplies. If it is summer, include sunscreen, a hat, a light rain jacket and good walking shoes. In winter, pack raingear, an umbrella, warm clothes and waterproof boots. At all times be sure to take plenty of water and some snacks. There are places to stop to get these supplies but you may not have much time to make extra stops if you plan to take the entire tour in one day.

In the course of this trip, you will be able to follow the Nisqually River along its journey from the summit of Mount Rainier to the Puget Sound and learn about the changes that have occurred within this 720-square-mile watershed over the past 200 years,[1] the problems that have arisen and the efforts that are being taken to protect this valuable and scenic area.

This guide has been divided into three sections.

ORIGINS OF THE NISQUALLY RIVER -- Mount Rainier and Its Glaciers
CONFLUENCE -- Where the Waters Meet
THE DELTA -- Life in the Lower Watershed

The information in this field guide has have been coded with different symbols. These designations have been created so that the user can easily spot text and sites that are of particular interest by locating the appropriate symbol throughout the guide. The symbols are as follows:

- Mount Rainier and its glaciers
- Water - Nisqually River and its tributaries, water quality, and water use.
- People - history of settlement, natural resource use, and Native Americans.
- Forest - types of trees, logging practices, and a history of logging.
- Agriculture - current and past practices, types of foods and land use issues.

The mileage given throughout the guide has two functions:

1) To provide a reference point for the user to know when to stop at an important site.
2) To give the user an idea of what to look for while driving along between stopping points.

The tour begins at the **Henry M. Jackson Memorial Visitor Center** in Mount Rainier National Park at mile 0.0. The mileage from that point for each site is indicated to the left of each stop. The time required to complete the tour will vary, but it is possible to make all the indicated stops (without taking any long hikes) and finish the trip in approximately 9 hours.

The tour ends at the **Luhr Boat Launch** northwest of Nisqually National Wildlife Refuge, approximately 5 miles from Lacey, and 7 miles from Olympia.

There are two general maps of the Nisqually Watershed on the following pages. The first one shows the physical boundaries of the watershed and prominent watershed features[2]. The second is a road map that shows the route of the tour. In addition, there is a map at the beginning of each of the three sections of the tour showing each segment of the tour.[3]

It is our hope that those who follow this route not only develop a sense of wonder about the region, but come to understand the importance of protecting our natural resources, such as water, that we rely on for survival.

Five principal public sites within the watershed have been designated as stopping points. Opening times, fees, and phone numbers may have changed - check ahead.

1. MOUNT RAINIER NATIONAL PARK

- Entrance fee ($10 per vehicle/2001 rates).
- The only road into the park that is open year-round is Highway 705 through the Nisqually entrance. In winter the road is open only up to Paradise. If you go in the winter, take traction devices or a four-wheel drive vehicle. The gate at the Longmire Museum closes at dusk, so make sure to leave the Paradise area in time to get through the gate before it is locked.
- The Jackson Memorial Visitor Center hours: 9 a.m. - 6 p.m. from the first weekend in May until September 25; from September 26 - October 12 it is open 10 a.m. - 6 p.m. After October 12 through the end of April it is open only from 10 a.m. - 5 p.m. on Saturdays, Sundays and holidays.
- The Longmire Museum is open daily from 9 a.m. - 5 p.m. from the first weekend in May until Sept. 25; and then 9 a.m. - 4:30 p.m. until the end of April.
- Sunshine Point campground is open year-round.
- Roads and weather: Scenery is beautiful throughout the year, but it is better to take this trip in the summer or early fall, due to variable road and weather conditions on Mount Rainier. If you go in winter, call (360) 569-2211 ahead of time for road and weather reports.

2. PIONEER FARM

- The price of a Pioneer Farm Tour is $5.50 for children (3-18) and Seniors (61+) and $6.50 for adults. The Native American Season Tour at the farm costs $5.00 for children (3-18) and Seniors; $6.00 for adults. A discount of $1.00 per person applies if a person does both tours the same day.
- The farm is open in spring (March 15 – Fathers Day) and fall (Labor Day – Thanksgiving) on Saturday and Sunday from 11 a.m. to 4 p.m. In summer (Father's Day – Labor Day Weekend) it is open daily from 11 a.m. to 4 p.m. Pioneer Farm Tours

are conducted anytime between 11 a.m. until 4 p.m.; and Native American Season Tours are on Saturday and Sunday at 1 p.m. and 2:30 p.m. The farm is closed from Thanksgiving until March 15.

- Group tours are available by reservation only. Call (360) 832-6300 for reservations or further information. A pamphlet available from the farm that describes all of the group tours.

3. **McALLISTER SPRINGS**

- The springs can be toured by appointment only. Contact the City of Olympia at (360) 491-0750 to arrange a tour.

4. **NISQUALLY NATIONAL WILDLIFE REFUGE**

- The visitor center is open Wednesday through Sunday from 8 a.m. until 4 p.m., except Christmas and New Year's Day.
- The refuge trails are open daily during daylight hours. The refuge office is open Monday through Friday, 7:30 a.m. to 4 p.m. Daily entrance fee is $3.00 per family. Golden Eagle, Golden Age, and Golden Access Passports, a Refuge Annual Pass and a Federal Duck Stamp admit one family. Children under 16 enter free.
- The Twin Barns Education Center provides exhibits about the refuge and classroom space for school groups. It is open to schools and other educational groups by reservation only throughout the week. It is open to the public until mid-July on weekends from 10 a.m. - 2 p.m.
- TRAILS: When using the refuge, please follow these rules. They were created to protect the wildlife that relies on the delta for survival.
    - ⇒ Boating is permitted in waters outside the Brown Farm Dike. Canoeists, kayakers, and small boaters should beware of hazardous tides, shallow waters, and wind and weather conditions around the Nisqually Delta. The nearest public boat access is Luhr Boat Ramp.
    - ⇒ Fishing from boats is permitted in waters outside the Brown Farm Dike. Fishing from the riverbanks is permitted only in the designated McAllister Creek Bank Fishing Area. There is no bank fishing access along the Nisqually River. Washington State regulations apply.
    - ⇒ The refuge is not open to hunting. However, waterfowl hunting is allowed by boat access only on Washington Department of Fish and Wildlife lands adjacent to the refuge.
    - ⇒ Sports such as jogging, bicycling, Frisbee throwing and kite flying are disturbing to wildlife and to other visitors, and are not allowed on the refuge.
- For more information contact Nisqually National Wildlife Refuge, 100 Brown Farm Road, Olympia, Washington 98516, or call (360) 753-9467.

5. **NISQUALLY REACH NATURE CENTER**

- The Center is open on Saturday and Sunday year-round from 12:00 to 4 p.m. You can observe birds from inside the Center or stand under the covered pier outside. For more information, call (360) 459-0387.

LIST OF PHOTOS

LIST OF FIGURES

THE NISQUALLY WATERSHED

From the Summit to the Sound

INTRODUCTION

The Nisqually River watershed is astonishingly beautiful. The diversity of the landscape, plants, animal and birds found between the summit and the sound is amazing. On the mountain Ptarmigan and Stellar's Jay inhabit the forest, while in the Delta, Blue Herons and Common Loons feed in the tidal marsh. Silver Fir stand tall along the steep mountain slopes while Red Alder spread out their limbs over valley streams. Above all parts of the watershed - prairies and wetlands, hills and valleys, rivers and streams - towers Mount Rainier, like a night watchman guarding the landscape below. In a sense, the mountain has been, and is, a protector. The headwaters of the Nisqually River and the forests, so vital to the health of the watershed, have been preserved since Mount Rainier National Park was created in 1899.

Although other rivers have the protection of a mountain, the Nisqually River is the only body of water in the United States with its headwaters in a national park and its mouth in a national wildlife refuge[4]. The protection of the Nisqually River is not the only thing that makes the Nisqually watershed unique. Efforts to preserve the area have included every facet of the watershed: the mountain, the forests, the rivers, the prairie, and so on. No component has been left out. As a result, this is one of the few areas in the Puget Sound region that has a representative section of almost all types of wildlife habitat.

Unfortunately, the uniqueness of the Nisqually watershed and the Nisqually River system has not kept them from being affected by population growth. The Nisqually River is plagued by many of the water quality issues that haunt other rivers in the Pacific Northwest. Rapid development without shoreline protection, septic system installation and maintenance, storm water runoff, logging practices and farming methods all threaten the water quality of the Nisqually River.

The Physical Geography of the Nisqually River Watershed

Because the Nisqually River watershed encompasses mountains and seashore in an elevation change from nearly 14,000 feet to sea level, its climate, hydrology and vegetation exhibit great variability. Underlying it all is a story of tectonics, volcanism and glaciation which continues to this day.

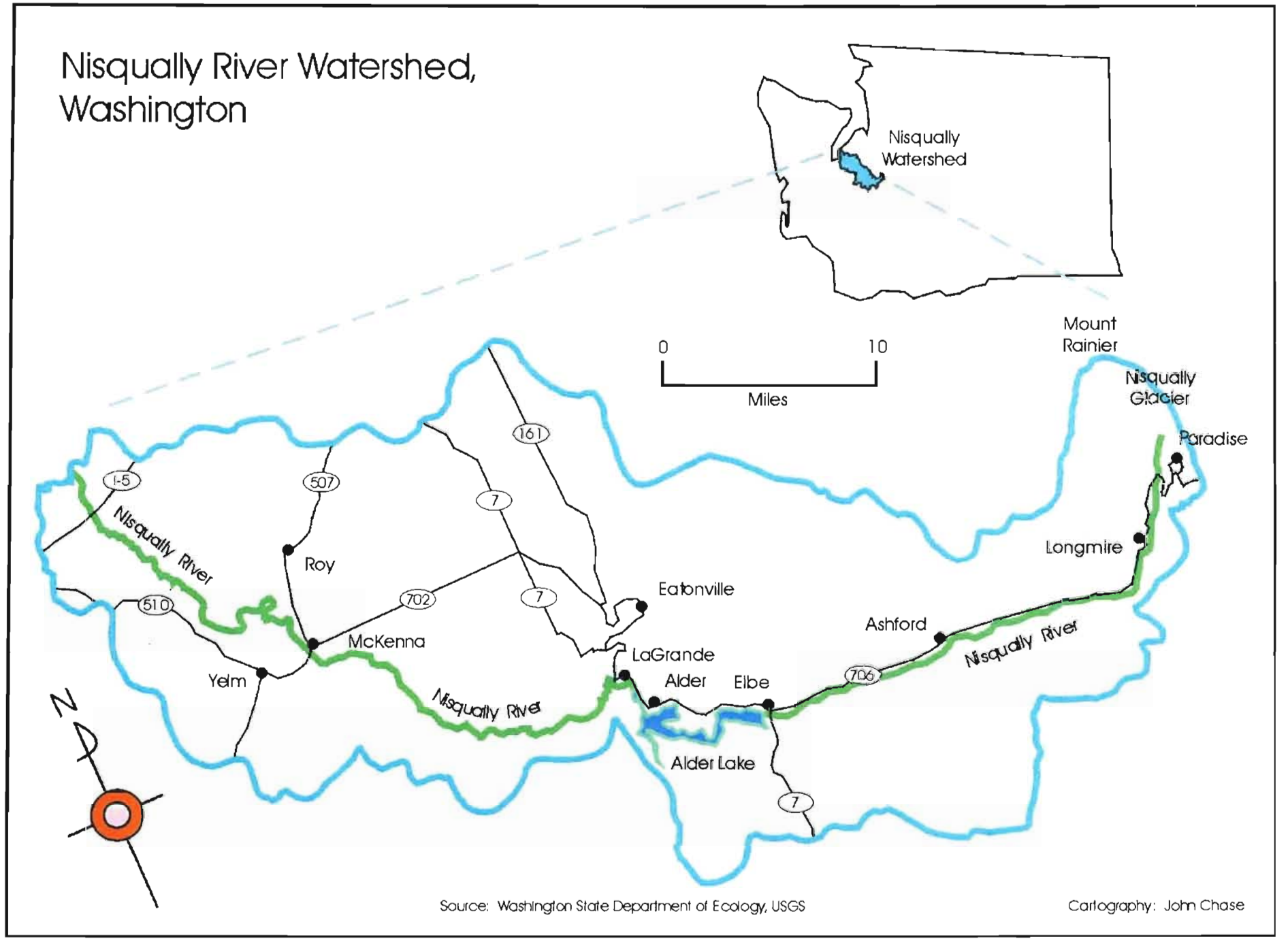

Figure 1. Nisqually Watershed

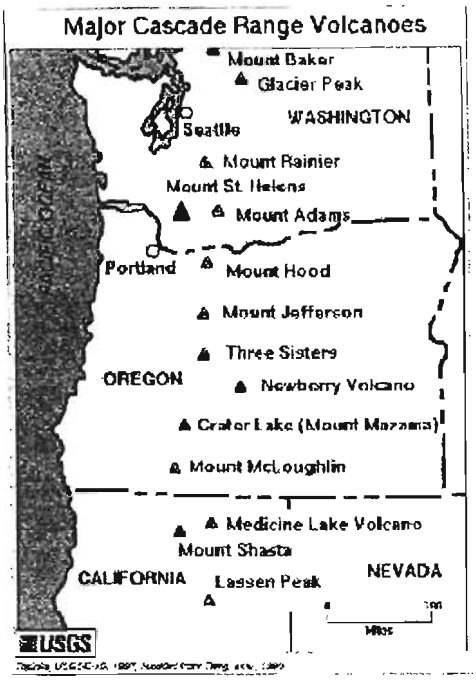

Figure 2. Major Cascade Range Volcanoes

Geology - The upper elevations of the watershed are at the Nisqually glacier on Mount Rainier. Rainier is a relatively young volcano, only about a million years old, compared to the other mountains in the Cascade Range (See Figure 2). Nonetheless, it has experienced repeated eruptions and lava flows (See Figure 3), which combined with the folding and uplifting of the Earth's surface, have allowed the peak to achieve its height of 14,410 feet (4,392 meters). The largest of the Cascade volcanoes, Mt. Rainier dominates the landscape of Western Washington, towering above the valley floor of the Nisqually basin lowlands. The mountain's eruptive history is revealed in layers of volcanic ash, lava flows, and the underlying volcanic rocks. Mt. Rainier is the most seismically active of the Cascade volcanoes, with an average of 30 earthquakes a year.[5] Within the watershed, recent evidence of the tectonic activity was revealed on February 28, 2001, when the magnitude 6.8 "Nisqually Earthquake" hit; its epicenter was just NE of Olympia.

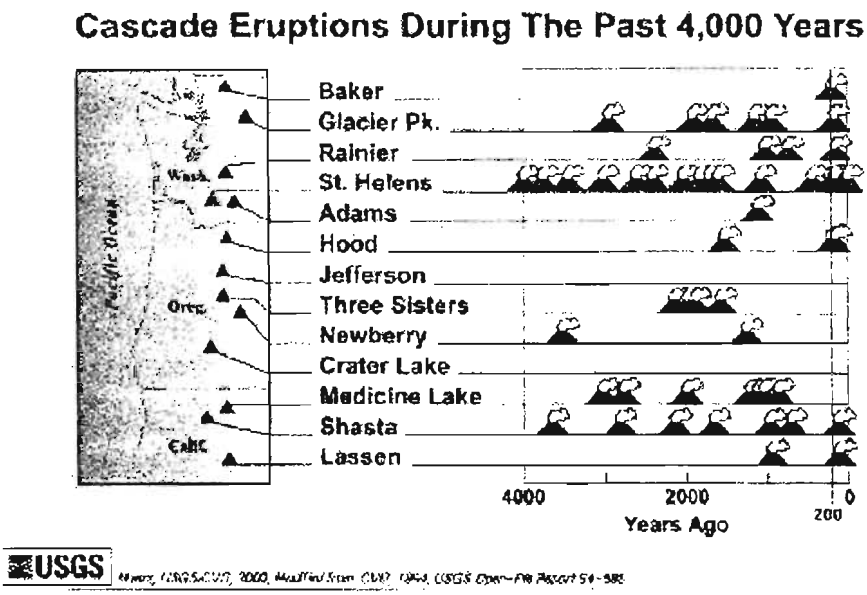

Figure 3. Cascade Eruptions During the Past 4,000 Years

The lower elevations of the watershed lie in the Puget Lowlands region, an immense delta and broad inland platform extending to the base of Mt. Rainier. Mudflows, ash deposits, and ancient sediments from Puget Sound merge here and contain rich fossil deposits of tropical and subtropical plants and saltwater invertebrates.

Glaciation - During the last ice age (about 20,000 years ago) Mt. Rainier was covered with glaciers that extended to the present-day Puget Sound. The mountain today has the most extensive glacier ice of any other mountain in the coterminous United States. The glaciers, covering approximately 35 square miles of the mountain surface, erode and shape the volcanic cone. They deform and flow continuously under the influence of gravity. Nisqually Glacier was measured moving as fast as 29 inches a day in 1970, with flow rates generally greater in summer due to meltwater at the base of the glacier. The glacier has been studied for size in movement since 1918; the long record of changes,

coupled with the geologic evidence found in glacial deposits, demonstrates the glacier's response to climate variations. For example, during the "Little Ice Age" (approximately 1350 to 1850 A. D.), the Nisqually Glacier advanced to a position 650 to 800 feet down-valley from the site of Glacier Bridge. Subsequently, the glacier retreated, losing about a quarter of its length, advancing again in the late 1970s and early 1980s due to unusually heavy snowfalls. The most recent measurements indicate that the glacier thickened between 1994 and 1997, indicating that it will probably advance during the first decade of the twenty-first century.[6&7]

Climate and Streamflow - The Nisqually watershed lies on the windward side of the Cascades, and thus experiences the heavy precipitation created by the influence of prevailing westerly winds coming off the ocean colliding with the topographic barrier of the mountains. The annual distribution pattern of precipitation on the west slope of the Cascades is low summer precipitation and high winter precipitation, most of which falls as snow in the higher elevations from fall through early spring. Snowfall rapidly increases with elevation. The long duration of the snow pack has economic importance. The stored snowfall melts and flows in summer, when it is needed most for agriculture and hydropower generation.

The climate data from the U.S. Geological Survey stations in the Nisqually watershed reveal the differences between the alpine environments of the eastern part of the watershed (See Figure 4A) and the maritime environment of the more westerly part of the watershed (See Figure 4B). Precipitation profiles for the eastern watershed (A) and the western (B) show the high variation in annual precipitation in the watershed. (Note difference in precipitation axis values)

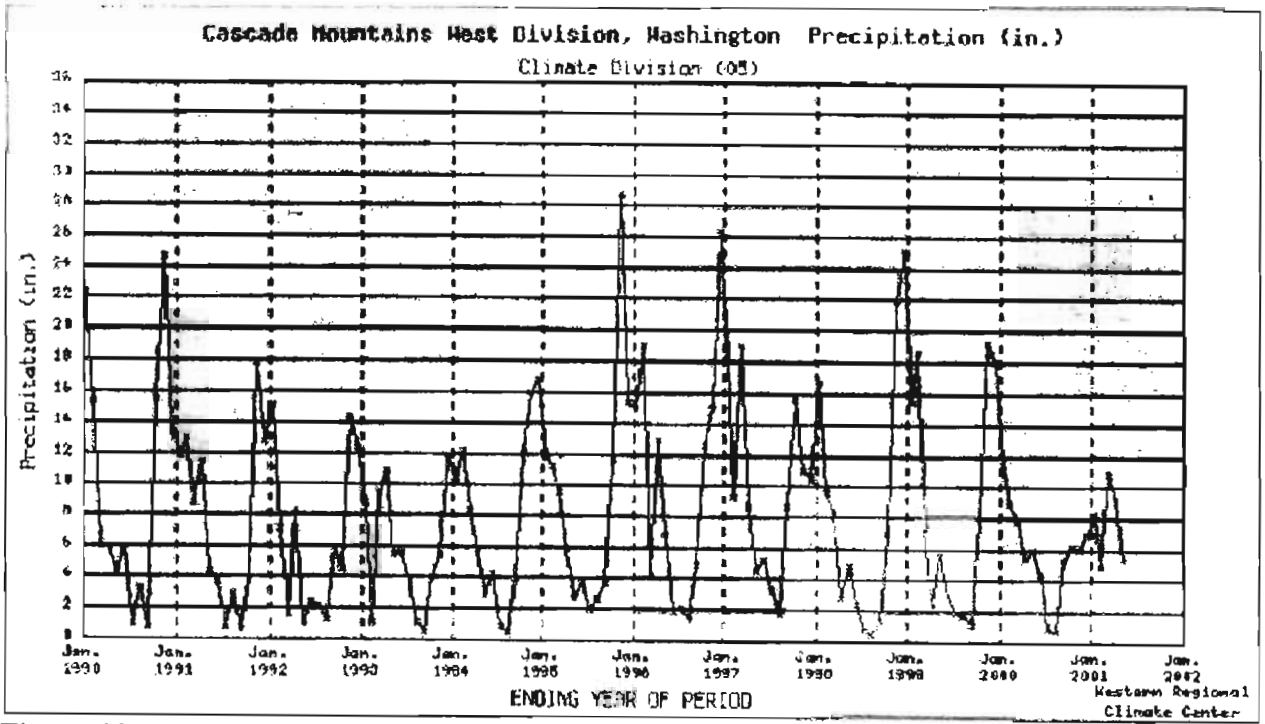

Figure 4A. Cascade Mountains West Division, Washington Precipitation (in.)

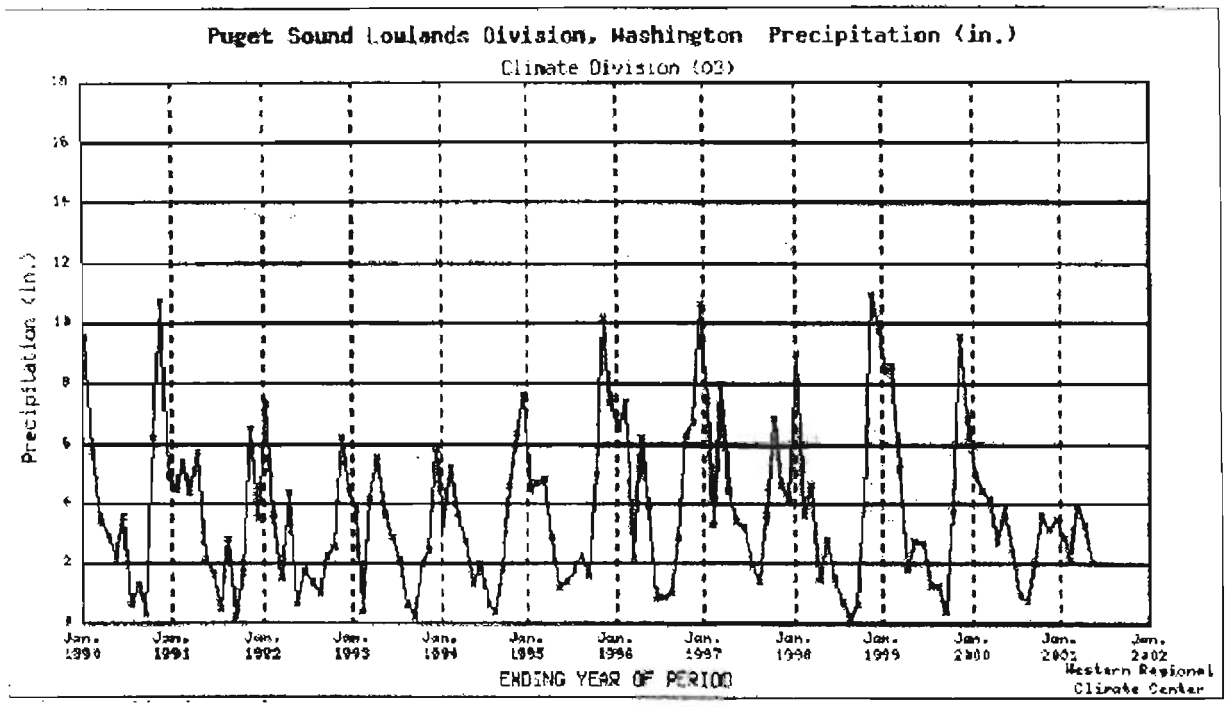

Figure 4B. Puget Sound Lowlands Division, Washington Precipitation (in.)

Paradise station on Mt. Rainier receives an average of nearly 682 inches of snow per year, while Puyallup station in the lowlands received on average only 6.3 inches. A similar gradient in rainfall exists: Paradise station receives on average 117 inches of rain per year, while Puyallup receives only 38.5 inches.

The average minimum temperature at Paradise Station is below freezing (30.0^{0}F), while Puyallup averages 40.7^{0}F, which is less than five degrees below Paradise's average maximum temperature of 45.1^{0}F. With its lower elevation and maritime influence from Puget Sound, Puyallup experiences an average annual maximum temperature of 61.9^{0}F.

Annual streamflow data for the Nisqually River reveal a seasonal flow (high winter flows; low summer flows) with occasional extreme peaks (See Figure 5).

The natural flow of the river has been greatly altered by hydroelectric projects, water diversions, and diking of the estuary beginning in 1904. The river also has levees in the lower five miles that restrain its flow.

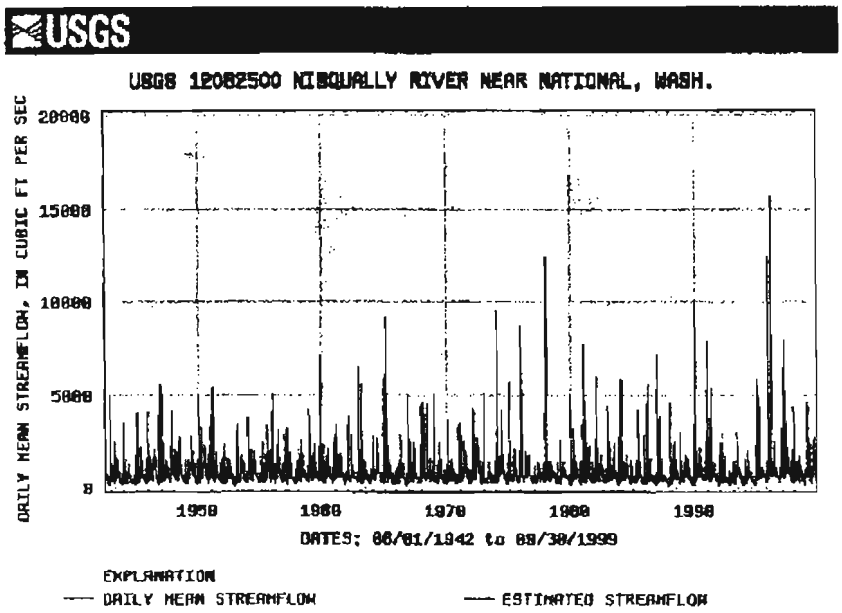

Figure 5. Nisqually River Streamflow near National, Wash

Vegetation and Land Use - The vegetation in the Nisqually River Watershed varies from alpine to rangeland. The easternmost part of the watershed, which contains the higher elevation areas of Mount Rainier and the high western slope of the Cascades, is dominated by alpine meadowland and tundra.[8] Moving westward through the watershed, and decreasing in elevation, the vegetation zones are dominated by silver fir on the upper slopes of Mount Rainier, by western hemlock in the middle slopes, and by Douglas fir from the lower slopes to Puget Sound. Although the entire watershed is dominated by forestland, there are small patches of rangeland shrub and brush at the lower elevations.

Approximately three-fourths of the watershed is forest land. The balance (apart form the glaciers and tundra at Mount Rainier) consists of a mix of herbaceous rangeland and forested wetlands. Human occupation has transformed the natural vegetation to cropland, reservoirs, and built-up areas (urban, residential and industrial), particularly in the western half.

REFERENCES TO FORWARD AND INTRODUCTION

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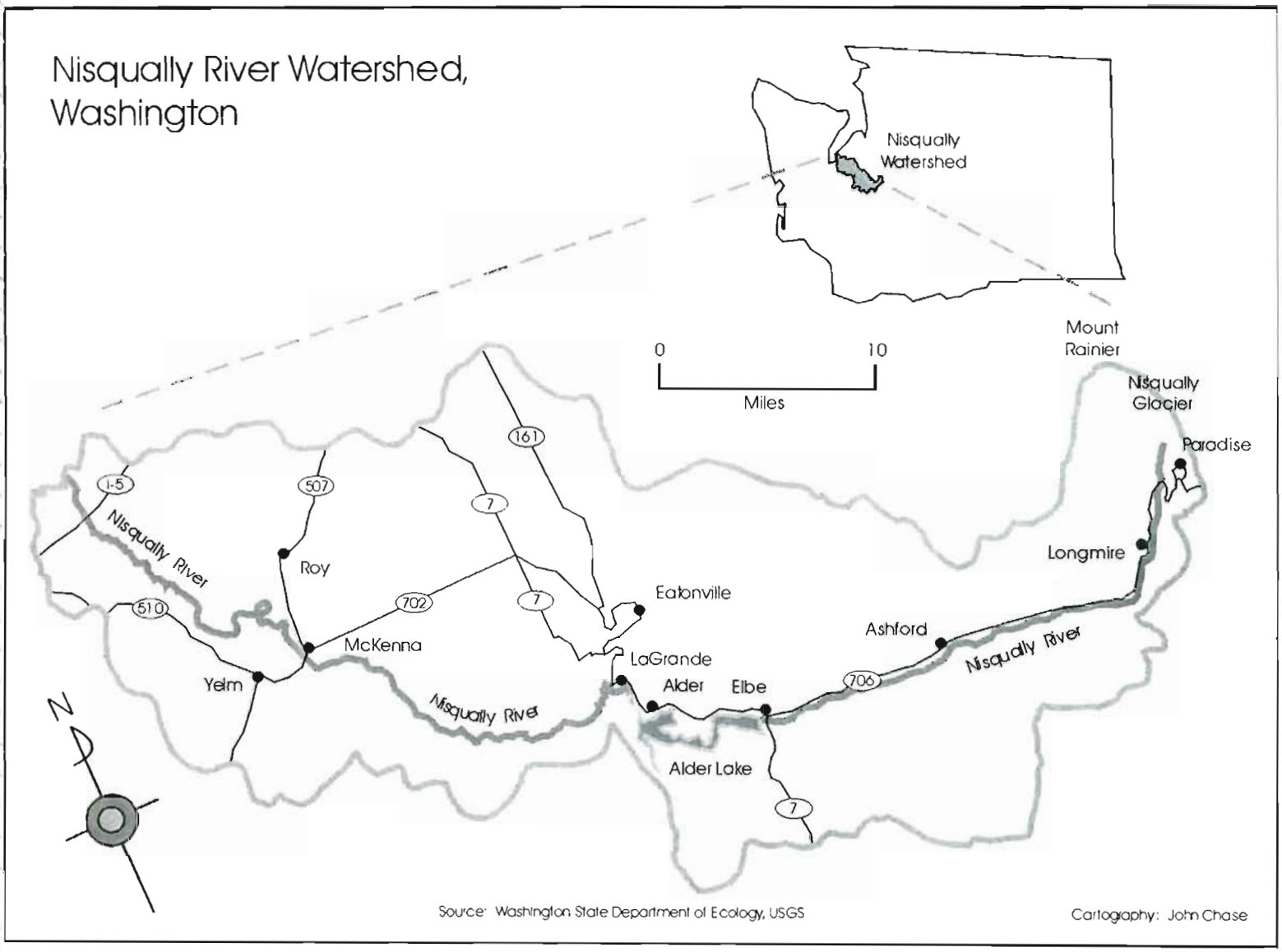
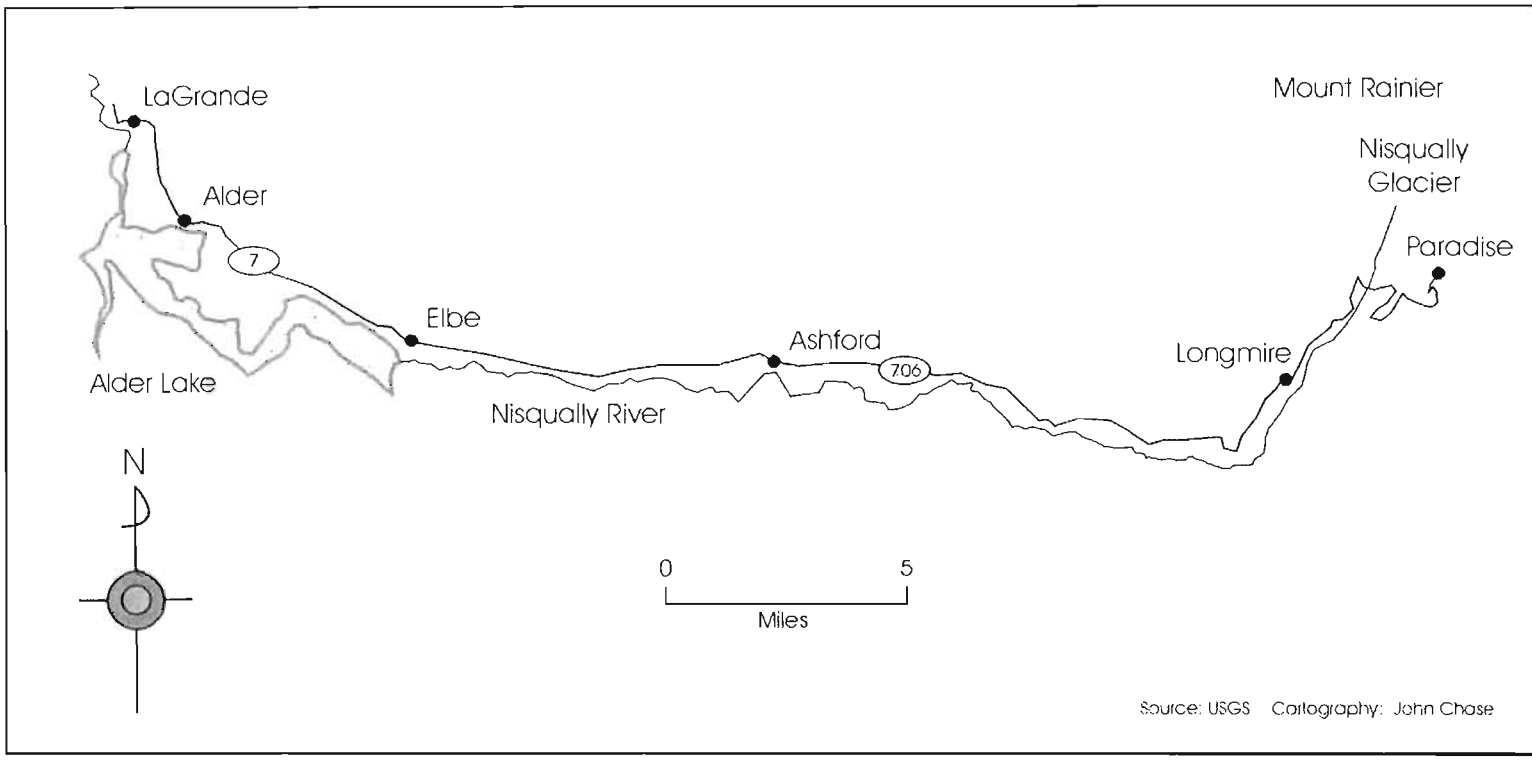


Figure 1. Nisqually Watershed

Section 1

ORIGINS OF THE NISQUALLY RIVER -

Mount Rainier and Its Glaciers



Section1: LaGrande to Paradise

ORIGINS OF THE NISQUALLY RIVER - Mount Rainier and Its Glaciers

0.0 **Henry M. Jackson Memorial Visitor Center**. The trip begins in the parking lot of the visitor center in Mount Rainier National Park. The visitor center has several exhibits that describe the wildlife in the park, the creation of Mount Rainier, and famous people associated with the park. There are videos to watch, a place to buy souvenirs and an observation deck. Signs on all sides of the observation deck in the visitor center show the ridges, glaciers and valleys of Mount Rainier. Minimum tour time without watching any videos: 30 minutes.

Mount Rainier - This 14,411-foot mountain was "Tahoma" to Native Americans throughout the region. It was named Mount Rainier in 1792 when Captain George Vancouver of the British Navy sailed into Puget Sound to explore the North Pacific Coast. He was so impressed with the mountain that he named it for his friend and superior officer, Rear Admiral Peter Rainier.[1]

1. MOUNT RAINIER (R. Hixson, 11-28-99)

During Mount Rainier's existence of less than a million years, fire and ice have continually interacted to mold, alter, and reshape its form and appearance. This composite volcano, the highest mountain in the Cascade Range, differs from other Cascade volcanoes in that about 90 percent of its eruptions have been in the form of lava flows. Although Mount Rainier has produced some ash, much of the ash and pumice on Rainier's slopes came from eruptions of Mount St. Helens and

Mount Mazama in Oregon.[2] As recently as 7,000 years ago the summit of Rainier was more than a thousand feet higher (See Figure 8). A series of eruptions and explosions began at that time, culminating in an extremely violent explosion 5,700 years ago that destroyed the summit. Enormous blocks of rock and glacial ice were torn from the mountain and landed miles away. Great avalanches roared down the mountain. Burning, steaming mudflows plunged with great speed down the valleys. Dark clouds blotted out the sun, and torrential rains fell.[3]

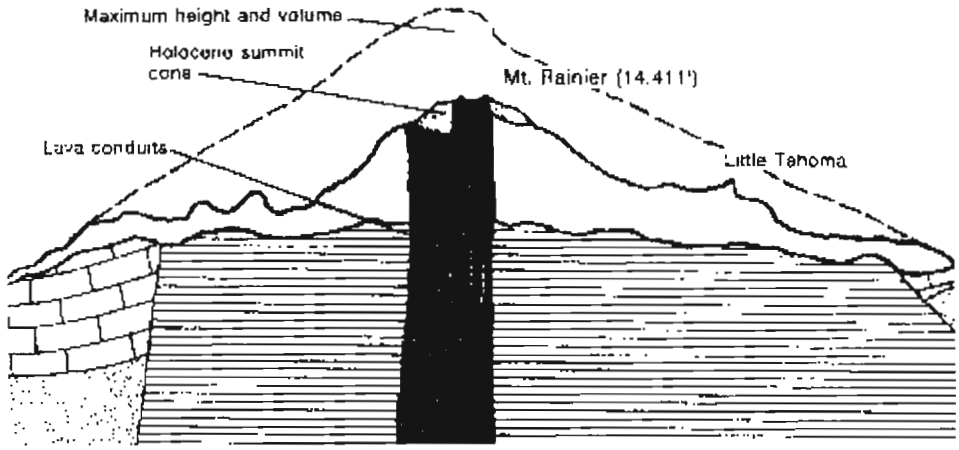


Figure 8. Cross section of Mount Rainier, with an approximate profile of the volcano's maximum size and its present outline.[4]

♦ **The Glaciers** - The cone of Mount Rainier, from summit to base, has been deeply furrowed and scarred by glacial erosion. Remnants of the volcano's outer layers show on the mountain flanks as sharp crags and ridges that jut through the ice and separate the glaciers radiating from the summit.

The middle zone, between the 8,000 - 10,000 ft. elevations, is the most favorable for glacier development.[5] Storm clouds from the Pacific Ocean drop a large part of their precipitation on the lower and middle elevations, giving these zones more precipitation than the summit. The estimated annual snowfall at middle levels on the western slopes of the mountain exceeds 100 feet. The glaciers also receive great volumes of snow that are blown off the summit or come down in avalanches.[6]

In all there are 26 glaciers that occupy 40 square miles of land surface in Mount Rainier National Park (See Figure 9). The glaciers that originate at the summit - Kautz, Tahoma, Wintrop, Emmons, Ingraham and Nisqually - are "refueled" after they advance 4000 feet or so down from the summit and reach the high snowfall zone. Another group of glaciers - including the South Tahoma, Paradise and Puyallup - start from basins in the mountain flanks at the middle elevations where more snow accumulates.[7]

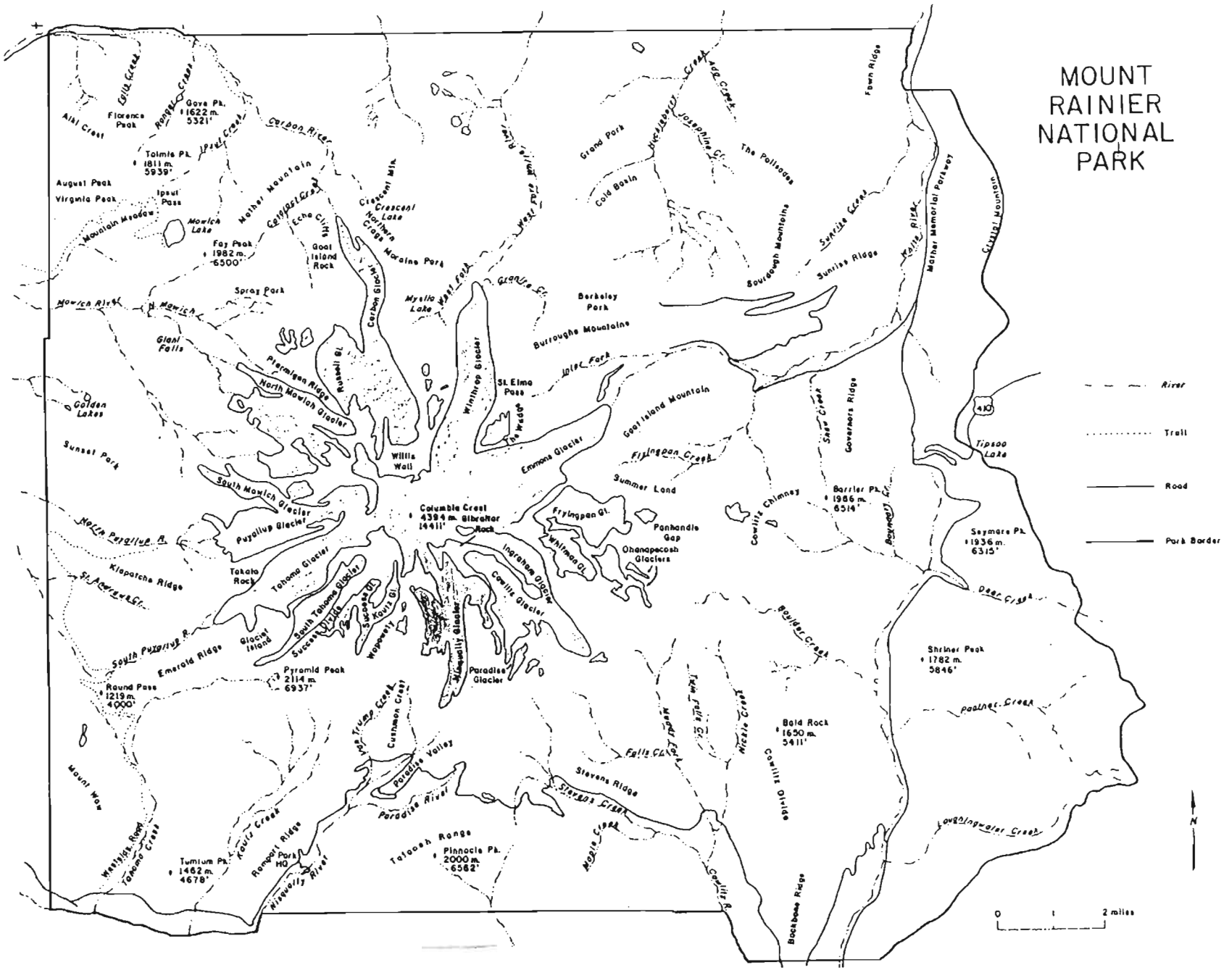
Periodic variation in climate affects the volume and length of the glaciers. The larger glaciers are surveyed and measured carefully at regular intervals because they are the source of major streams that supply hydroelectric power and irrigation water to the region. Flows in these rivers tend to be low in winter and high in the summer melt season.

♦ **Nisqually Glacier** - The Nisqually Glacier is the major source of water for the Nisqually River. It is the seventh largest of the 26 major glaciers on Mount Rainier, and one of six originating at the summit. Near the upper surface of the Nisqually Glacier lies a layer of thicker, heavier ice created by many years of deeper-than-usual snowfall. This ice flows down slope like a slow-motion wave, eventually pushing the surface of the glacier forward when it reaches the terminus.[8]

As with all large ice masses, the Nisqually Glacier's shape changes over time. It grows larger and extends downhill during cooler periods with heavy snowfall. This river of ice shrinks and the tip recedes uphill in warmer periods with light snowfall. During the Pleistocene Ice Age, the Nisqually Glacier pushed its rocky debris beyond the current town of Ashford (about 25 miles from the summit), extending itself as a single sheet of ice, in some places 1,600 feet thick. In warmer times, the glacier has retreated, moving back up the mountain as much as 10 inches in a day.[9]

2. NISQUALLY GLACIER (J. Robinson 07-04-01)

To the east of the Nisqually Glacier is the Paradise-Stevens Glacier, whose runoff also feeds the Nisqually River. In addition, to the west of the Nisqually Glacier are the Kautz Glacier and the South Tahoma Glacier whose waters also enter the Nisqually River. Because the headwaters of the Nisqually are in Mount Rainier National Park, which has been a protected area since 1899[11], human disturbance and many water quality threats have been minimized at the river's source.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4394 m. Gibraltar
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Liberty Cap
14112'
Point Success
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Little Tahoma
11138'
Gove Pk.
11622 m.
5321'
Tolmie Pk.
1811 m.
5939'
Fay Peak
1982 m.
6500'
Pyramid Peak
2114 m.
6937'
Round Pass
1219 m.
4000'
Tumtum Pk.
1462 m.
4678'
Pinnacle Pk.
2000 m.
6562'
Barrier Pk.
1986 m.
6514'
Seymore Pk.
1936 m.
6315'
Shriner Peak
1782 m.
5846'
Bald Rock
1650 m.
5411'
Tipsoo Lake
Sunset Park
Golden Lakes
Mowich Lake
Spray Park
Mowich River
Giant Falls
Fryingpan Creek
Summer Land
Panhandle Gap
Ohanapecosh Glaciers
Emmons Glacier
Winthrop Glacier
Willis Wall
St. Elmo Pass
Curtis Ridge
Goat Island Mountain
Governors Ridge
Sunrise Ridge
Sourdough Mountains
Berkeley Park
Burroughs Mountains
Grand Park
Cold Basin
The Palisades
Fawn Ridge
Glacier Island
Emerald Ridge
Klapatche Ridge
Tokata Rock
Tahoma Glacier
South Tahoma Glacier
Success Cleaver
Success Glacier
Kautz Glacier
Wapowety Cleaver
Nisqually Glacier
Paradise Glacier
Ingraham Glacier
Cowlitz Glacier
Whitman Glacier
Frying Pan Gl.
Cowlitz Chimney
Boulder Creek
Deer Creek
Paradise Valley
Paradise River
Stevens Ridge
Stevens Creek
Maple Creek
Cowlitz Divide
Backbone Ridge
Tatoosh Range
Mount Wow
Kautz Creek
Ramparts Ridge
Park HQ
Nisqually River
Tahoma Creek
Westside Road
Carbon River
Ipsut Creek
Ipsut Pass
Mother Mountain
Cataract Creek
Echo Cliffs
Goat Island Rock
Crescent Lake
Northern Crags Moraine Park
Carbon Glacier
Mystic Lake
West Fork
Granite Cr.
Russell Gl.
North Mowich Glacier
South Mowich Glacier
Puyallup Glacier
Puyallup River
South Puyallup R.
St. Andrews Cr.
Mowich River
North Mowich
August Peak
Virginia Peak
Mountain Meadow
Florence Peak
Alki Crest
Little Green
Ranger Creek
Mowich Lake
Fay Peak
Cataract Creek
Crescent Mtn.
Carbon Glacier
Mystic Lake
Granite Cr.
Russell Gl.
Pleasant Ridge
Golden Lakes
Sunset Park
Willis Wall
Winthrop Glacier
St. Elmo Pass
Ice Fork
Emmons Glacier
Fryingpan Creek
Summer Land
Cowlitz Chimney
Fryingpan Gl.
Whitman Gl.
Panhandle Gap
Ohanapecosh Glaciers
Ingraham Glacier
Cowlitz Glacier
Paradise Glacier
Wapowety Cleaver
Kautz Gl.
Success Glacier
Success Cleaver
South Tahoma Glacier
Tahoma Glacier
Tokata Rock
Klapatche Ridge
Emerald Ridge
Glacier Island
South Puyallup R.
Puyallup Glacier
South Mowich Glacier
North Mowich Glacier
Pleasant Ridge
Russell Gl.
Carbon Glacier
Mystic Lake
West Fork
Granite Cr.
Burroughs Mountains
Berkeley Park
Grand Park
Cold Basin
The Palisades
Fawn Ridge
Sourdough Mountains
Sunrise Ridge
Sunrise Creek
Governors Ridge
Goat Island Mountain
Curtis Ridge
Mother Mountain
Cataract Creek
Echo Cliffs
Goat Island Rock
Crescent Lake
Northern Crags Moraine Park
Carbon River
Ipsut Creek
Ipsut Pass
Mowich Lake
Fay Peak
Spray Park
Mowich River
Giant Falls
Golden Lakes
Sunset Park
Willis Wall

Day Hikes – At the visitor's center is a map and a description of hikes available in the area (See Figure 10). If you want to get a better look at the Nisqually Glacier or hike farther up the mountain, there are two hikes that can be taken.

Nisqually Vista Trail - This is an easy loop from which you can enjoy views of the mountain and the entire length of the Nisqually Glacier. A trail leaflet, available from the box at the trailhead, will inform you about the trail. 1.2 miles; 1 hour.[12]

Moraine Trail - This trail is a spur off the Dead Horse Creek Trail leading to the rock moraine at the edge of the Nisqually Glacier. Wear sturdy boots for this hike and use caution while crossing loose rocks. Rocks near the edge may be very unstable. 3 miles; 1 ¾ hours.[13]

Exit the parking lot to begin the trip.

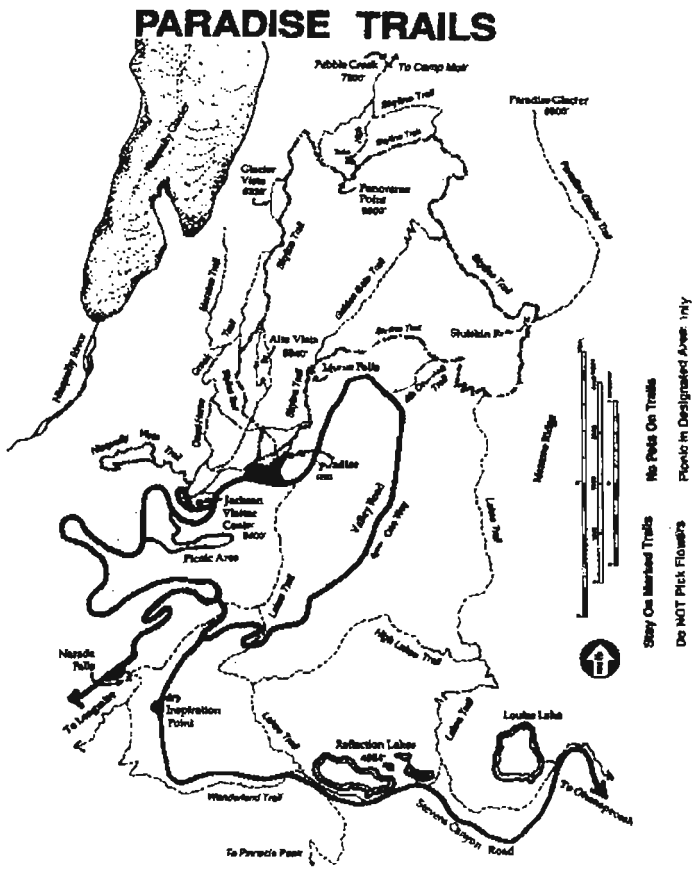


Figure 10. Paradise Trails.[14]

0.1 On the left are Noble Firs that have been wind-cropped by severe winds in this sub-alpine zone.

15

NOBLE FIR *(Abies procera)* - These trees are tall (over 200 feet) and beautifully symmetrical. The bark is smooth with resin blisters when young and changes to brownish-gray plates with age. The needles are bluish-green but appear silver because of 2 white rows of stomata on the underside and 1-2 rows on the upper surface. The needles are generally twisted upward so that the lower surfaces of branches are exposed. Its strong needle retention makes it a favorite source of Christmas wreaths.

Noble Firs are native to the Siskiyou Mountains of northern California and the Cascade and Coastal ranges of Oregon and Washington. It grows in middle- to upper-elevation coniferous forests and is often associated with Silver Fir (*Abies amabilis*) and other conifers. The best stands are found in moist, middle elevation areas with deep, rich soils. Middle-elevation stands are usually more open than low-elevation forests and occur on poorer, thinner, rockier soils in areas subject to frequent disturbance by wind, snow and fires.[16]

17

2.4 ♦ As you round the corner at mile 2.4, you get the first good glimpse of the Paradise River on your left. The Paradise River originates from the Paradise-Stevens Glacier, and combines with Edith Creek before reaching Narada Falls.

† The Paradise-Stevens Glacier was named after General Hazard Stevens. Stevens and P.B. Van Trump led the second attempt to climb Mount Rainier in 1870, thirteen years after the first attempt. They carefully planned an approach to the summit up a narrow arete, the Cowlitz Cleaver, that separates the snowfields of Cowlitz and Nisqually Glaciers and leads to Gibraltar Rock, close to the summit. When Sluiskin, the Native American guide, realized that Stevens and Van Trump really meant to go to the top, he refused to accompany them because he believed that an evil spirit lived in a lake of fire at the summit. He promised to wait three days and asked for a letter absolving him of blame for their deaths if they did not come back. The two climbers did reach the top but had to spend the night there because of darkness. They thought they would freeze to death until they discovered ice caves and steaming, foul-smelling vents on the summit. They spent an uncomfortable night roasting by the vents and shivering in the caves, but survived and descended the next day. When the anxious Sluiskin saw the two ice-encrusted figures emerging from the fog that had enveloped the mountaintop, he fled in terror, believing them to be ghosts. After convincing him they were real and alive, the party returned to the settlement. The Stevens route to the summit via Gibraltar is now considered the safest approach.[18]

3. PARADISE RIVER (R. Hixson, 11-12-99)

2.5 The Paradise River is bordered by Pacific Silver Fir.

19

PACIFIC SILVER FIR *(Abies amabilis)* - This large fir is characterized by its spire-like conical crown, short down-curving branches and flat, fern-like foliage. The average height is 100-180 feet tall but it can grow up to 300 feet. Its needles are crowded, spread forward in two rows, and curve upward on the upper twigs. These flat needles are often gray when new but turn shiny dark green after a year. The bark is light gray and smooth at first but later becomes scaly and reddish-gray.

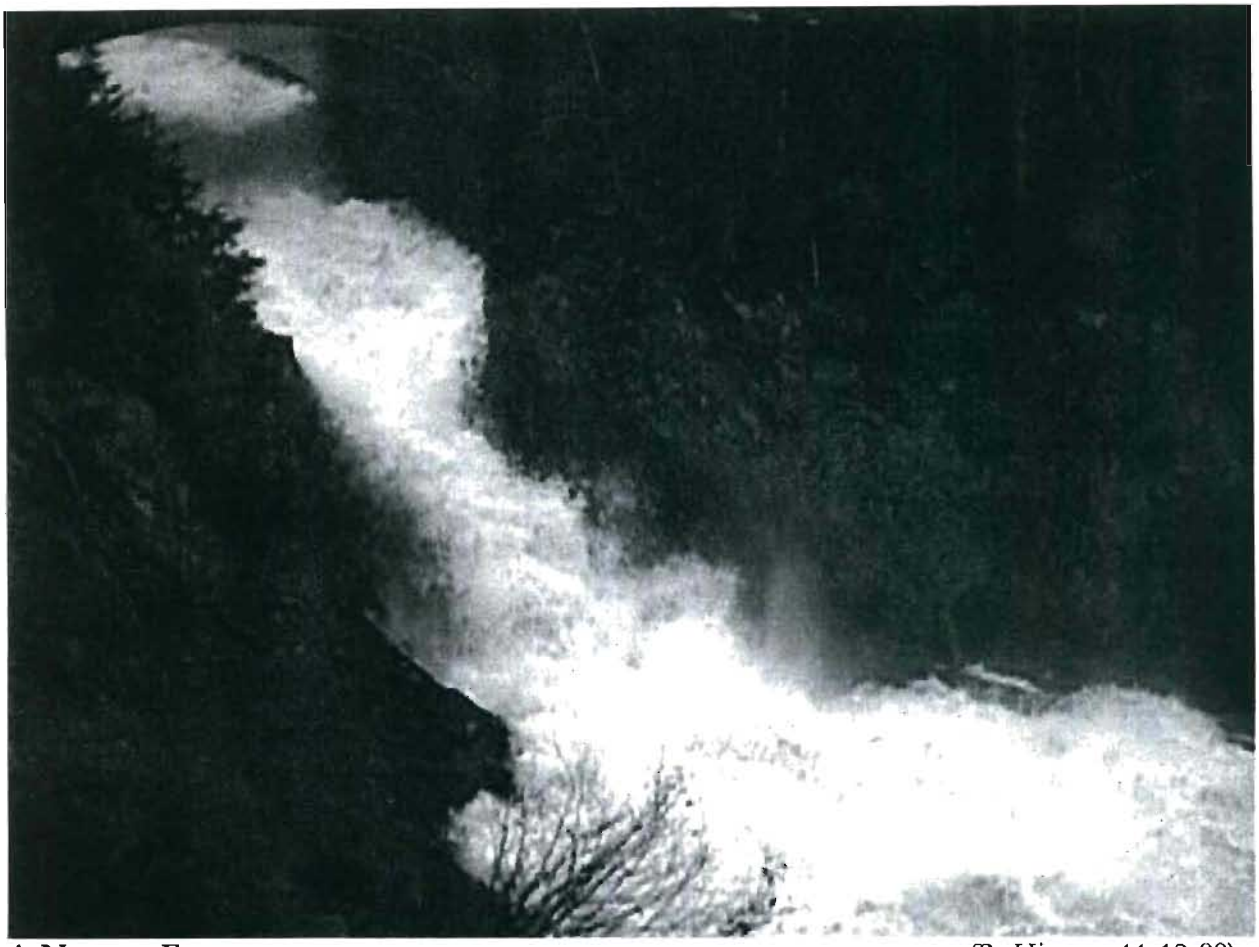
The best habitat for the Pacific Silver Fir is cool, wet regions, including coastal fog belts and interior mountain valleys in coniferous forests. They range along the Pacific coast from extreme SE Alaska to Western Oregon and in local vicinities in NW California.[20]

21

2.7 Turn left into the parking lot to view Narada Falls. This magnificent waterfall is 168 feet tall, 3

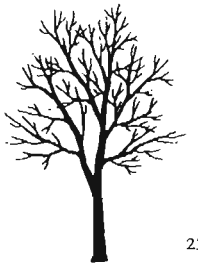
feet higher than Niagara Falls.[22] There is a 0.2-mile hike to the bottom of the falls. The trail drops 200 feet, so be ready for a tough climb back! The falls can be more easily enjoyed looking down from the bridge that goes over the top part of the falls.

After the water cascades down Narada Falls, the Paradise River is joined by four small tributaries and gathers volume before emptying into the Nisqually River.



4. NARADA FALLS (R. Hixson, 11-12-99)

3.6 On your left are stands of Mountain Alder. Mountain Alder is able to survive at this altitude because it can tolerate being frozen.



23

MOUNTAIN ALDER *(Alnus tenuifolia)*. Mountain Alder usually grows into a large shrub with spreading, slender branches but sometimes can grow up to 30 feet tall to form a small tree with several trunks and a rounded crown. The wide leaves are dull green and deeply double-toothed. The bark is gray, thin and smooth when the tree is young but becomes reddish-gray and scaly with horizontal bars. The Navajo Indians made a red dye from the powdered bark.

Mountain Alder is distributed from central Alaska and Northwest Canada south in the mountains to central California, southeast Arizona and southwest New Mexico. It grows in cold climates and medium to high elevations on the banks of streams, swamps and mountain canyons in moist soils.[24]

25

4.9 On your left is the entrance to Ricksecker Point (named for the engineer who surveyed the Paradise road) which offers a view of the Nisqually drainage. The view stretches from the summit of Rainier where the glacier begins to the braided river channels disappearing into the lowland forest. If you look south you can see the Tatoosh Range, which ends abruptly at Eagle Peak directly above Longmire museum. The Tatoosh Range is the southern end of the great U-shaped warping of strata – the Unicorn Syncline – which underlies Mount Rainier. This syncline was formed by ancient lava and ash flows that predate the Rainier volcano.[26]

6.0 Cross bridge and turn left into the parking lot. Dense forests have replaced sub-alpine meadows. On the south side of the lot a sign labeled "Forests of Slopes and Valleys" describes the main types of trees found at this elevation: Noble Fir, Alaska Cedar and Pacific Silver Fir. Just to the right of the sign are several Alaska Cedar.

27

ALASKA (YELLOW) CEDAR ***(Chamaecyparis nootkatensis)*** - The Alaska Cedar or Yellow Cedar is a medium-sized tree with branches that droop and give the tree a wilted appearance. The fibrous and shreddy bark is brown-orange, pink-brown or gray-brown with thin, long, narrow, vertical or spiral fissures. Usually this tree grows to a height of 80-100 feet and is two to three feet thick. They are very long-lived and have been know to reach 3,500 years of age.

This slow-growing tree is commonly found where the climate is cool and humid. Abundant in stream bottoms, basins, valleys and moist slopes, it grows singly or in small clumps. Usually grows in mixed conifer forests, but can be found in pure stands of the same age, where spruce and hemlock have been destroyed by fire. Alaska Cedar is rarer in deeper valley soils where it cannot compete with Douglas-fir and Western Hemlock, which outgrow it in early life. The durable wood has a pleasant, resinous odor. Northwest coast Native Americans made canoe paddles from the wood and carved ceremonial masks from the trunks.

Alaska Cedar ranges along the Pacific coast from S and SE Alaska southeast to mountains of W Oregon and extreme NW California. Alaska Cedar can grow in specific areas farther inland. They are usually found between 1,800-6300 ft.[28]


29

♦ Walk up to the north side of the Nisqually Bridge and look up toward the mountain. In 1830's the ice from the Nisqually Glacier reached down the canyon to about 1,500 feet from the bridge site. Photographs of the first cars to drive to Paradise in 1911 show the glacier barely above the crossing.[30]

Today the glacier has receded and "flour"-laden chocolate-colored water sweeps over a field of cobbled rocks deposited in previous eons at the glacier's foot. At this point, only two tributaries and runoff from the surrounding hills have contributed flow to form the river and yet the Nisqually River barely keeps to its cobbled bed in this steep upper stretch. It jostles and tugs at each rock in its path, coursing ahead and meandering down the mountain.

5. THE NISQUALLY RIVER NORTH OF THE NISQUALLY BRIDGE (R. Hixson, 11-12-99)

Notice the stand of dead trees about a half-mile below the Nisqually Bridge and the distance between the standing forests on each side of the river. This riverbed was scoured in an outburst flood of 1955. Trees were killed by abrasion from the rocks being carried in the flood and by root burial under the sediment load deposited when the flood water subsided.[31]

5.9 ♦ On your left is Christine Falls. The highest part of the falls is below the road so you will need to park and walk to see it. The falls are named for the daughter of P.B. Van Trump, who first climbed Mount Rainier with Hazard Stevens.[32]

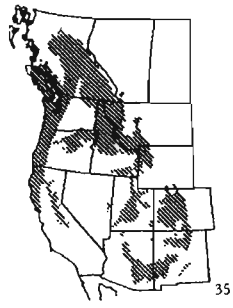
8.4 As you drop into the boreal forest from the sub-alpine region, Douglas-fir begins to appear.


33

DOUGLAS-FIR ***(Pseudotsuga menziesii)*** - This wide-ranging species grows from 70 to 250 feet tall. The branches spread out and droop slightly, the buds are sharply pointed and the bark is very thick, fluted, ridged, rough and dark brown.

Under natural conditions, Douglas-fir establishes primarily after fires on wetter sites. The trees can live for a thousand years, due largely to a very thick bark that allows them to survive moderate fires. Many ancient old-growth forests contain Douglas-fir.

The range of the Douglas-fir includes central California, western Oregon and Washington, parts of the Rockies and extends north to Alaska. It grows in a wide variety of environments from extremely dry, low elevation sites to moist sites. On the west side of the Cascades and Sierra Nevada, it is often the predominant species, but usually occurs in conjunction with several other conifers. On the coast, it is associated with Western Hemlock and other conifers.[34]


35

9.2 ♦ Park in the turnout on the right side of the road. Cross over the road and walk to the trailhead. Walk down the path on the left to the river. There are two foot bridges here where you can cross the Nisqually River. As the river tumbles downhill, the stream divides into two parallel streams for a stretch, then soon reunites in a pattern known as "braiding". Notice the debris caught on the small islands in the middle of the fast flowing current. As the water changes course it leaves its burden high and dry until its course shifts again.

Just south of this spot the Paradise River flows into the Nisqually.

6. THE NISQUALLY RIVER NEAR MILE 9.2 (R. Hixson, 11-12-99)

9.9 On both sides of the road are stands of Western Hemlock, another species of low elevation forests.

36

WESTERN HEMLOCK (*Tsuga heterophylla*) - Western Hemlock is a stately, graceful and handsome tree. Tall and straight, it commonly forces itself up through the existing forest canopy. The wood is a pleasing off-white, tinged with pale purple, with small, black knots. It is an evergreen tree that grows in mineral soils in moist, shadowy areas. It grows at a medium speed to about 150-200 feet tall. The trunk diameter is usually three to four feet. It has rough bark that is reddish-brown, scaly, thick, furrowed and mottled in old trees. Its roots are very small so it is easily blown over.

Because it tolerates deep shade exceptionally well, hemlock can grow to maturity in the thickest, deepest forest. Sprouting from living stumps, it replaces itself easily and can out compete other species, eventually dominating a forest.

Western Hemlock is distributed on the Pacific Coast from Alaska south, thoughout western Canada into central California and east to Idaho and Montana. This species grows exclusively in the Pacific Northwest and is one of the most important timber trees of the region. It usually grows with Douglas Fir, Red Cedar and Sitka Spruce.[37]

38

10.9 ⛰ Continue down the road, with the Nisqually River on your left. On your right, you will see boulders deposited by a lava flow.

11.2 ↟ Turn left to go to the Longmire Museum.

7. THE LONGMIRE MUSEUM (R. HIXSON, 11-12-99)

The museum offers a concise history on the formation of Mount Rainier, the people who were important in its history, and a description of the wildlife and vegetation that occurs in different regions of the park. The museum was named after James Longmire, an early settler in the area. Longmire assisted Samuel F. Emmons of the U.S. Geological Survey in the early geologic reconnaissance of Mount Rainier and the surrounding region. Longmire climbed the mountain in 1883. On that trip he discovered mineral springs on the southwest side, and later built a resort hotel at the site, operating the Longmire Springs Hotel and Bath from 1906 until 1926.[39] The Longmire hotel site became a hub for visitors to the Nisqually River watershed. In 1899, only 200 people visited Mount Rainier. In 1906, about 2,000 people ventured to this part of the park. Today, 2,000,000 visitors come to Mount Rainier each year.[40]

Across the road from the Longmire Museum is the Trail of Shadows (See Figure 11). This self-guided nature walk goes through a lovely cool forest, past mineral springs and to a cabin built in 1888. Outstanding features are numbered and keyed to a booklet, copies of which may be picked up at the start of the trail. To follow the booklet, go counterclockwise on the loop trail. The loop is ¾ mile long and takes about 30 minutes.[41]

Information about the other trails seen in Figure 4 can be obtained at the Longmire Museum. Continue the road trip by turning left onto Highway 706 down the mountain.

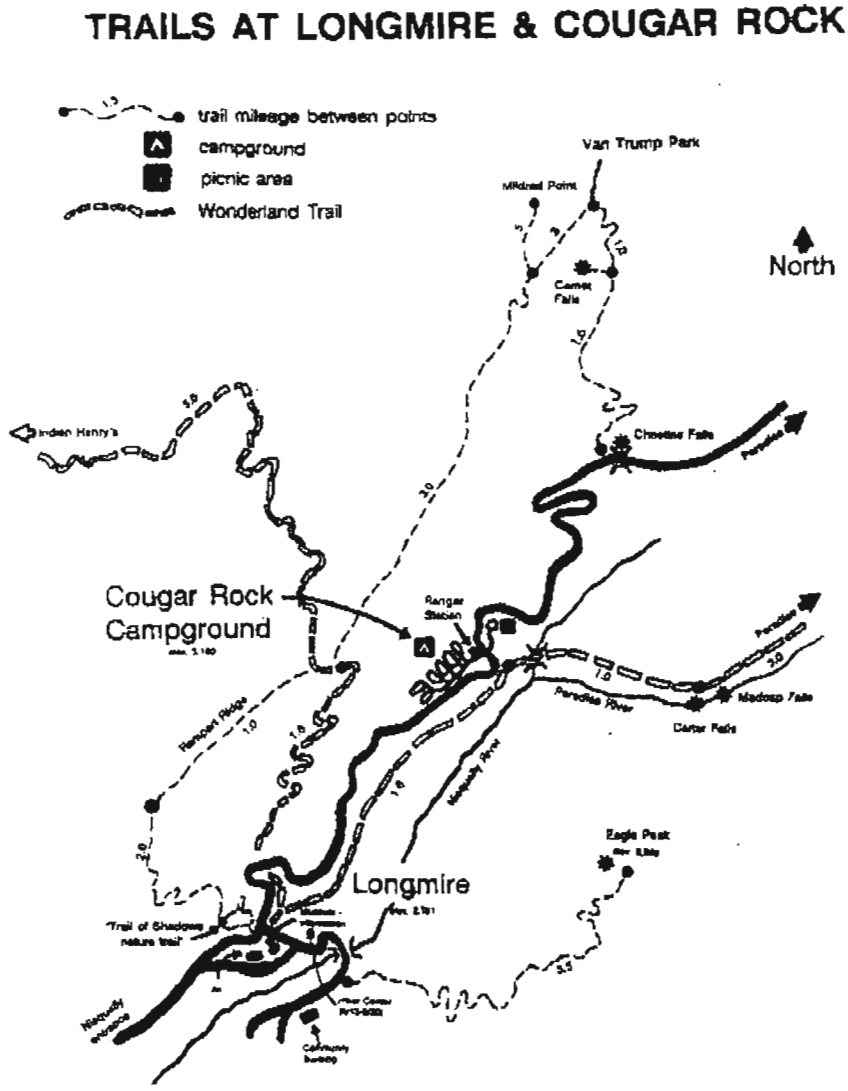


Figure 11. Trails at Longmire and Cougar Rock.[42]

12.6 ♦ During this mile, notice on your left that the river is beginning to flatten out and become wider as you leave the steep elevations.

13.3 On the right is a sign that describes the types of trees that are common in low elevation forests. Western Red Cedar is one of the species common to this area.

43

WESTERN RED CEDAR (*Thuja plicata*) - This well-tapered pyramid-shaped tree has a straight trunk covered with cinnamon colored bark. Western Red Cedar normally reaches heights of 150 to 200 feet in the best growing conditions: areas of abundant precipitation. This tree will tolerate long, cold winters, but does best in areas of moderate temperature. It is generally found near streams, moist flats and gentle lower slopes and seems to favor the cooler, moister north slopes. Since the tree does not normally develop a long tap root, a high wind can easily topple a large tree.

Western Red Cedar was very important to Native Americans, who used it in construction of shelter, tools, and canoes. Woven bark became clothing, art objects and religious implements.

Western Red Cedar range from SE Alaska along the coast to NW California. They also occur from SE British Columbia to the Rocky Mountains in Western Montana. They often form widespread forests with Western Hemlock and other conifers.[44]

45

14.2 ↑ Turn left into the parking lot at Kautz Creek (restrooms and picnic tables here). Walk across the road at the designated crossing point and follow the boardwalk to view Kautz Creek, named for Lieutenant A.V. Kautz. The first officially recorded attempt to reach the summit of Rainier was made by Lieutenant Kautz and his party in 1857. Kautz, Dr. R.O. Craig, four soldiers and a Nisqually guide almost made it to the top but were turned back by high winds and violent storms. Their approach was from the south and over Kautz Glacier, the source of Kautz Creek.[46]

♦ Once you reach the boardwalk, note the signs along the path. They describe how the flood of 1947 is a recent example of how agents other than ice, some of them associated with glaciers, also shape this area. Usually water from melting ice collects and flows in river torrents, cuts across the land and sweeps silt along, eventually redepositing it downstream. But sometimes massive chunks of ice block a drainage channel, back up melt-water, then burst and send the impound water down-valley in devastating surges. This is what happened in October of 1947 on Kautz Creek. Within a span of about eight hours, following heavy rains, successive mudflows roared down Kautz Creek to the Nisqually River, leaving behind several cubic miles of muddy debris in the Kautz valley. Witnesses reported that large trees, and boulders 13 feet in diameter, were borne along by the mudflow, which had the consistency of wet cement. Many trees buried in the flow are being exhumed as the creek washes away mud that was as deep as fifty feet.[47] Kautz Creek, along with Devil's Dream Creek, Fisher's Hornpipe Creek, Pearl Creek and Pyramid Creek (all Nisqually River tributaries), flows into the Nisqually River shortly after this point.

8. KAUTZ CREEK (R. Hixson, 11-12-99)

16.4 ♦ Here the bridge crosses over Tahoma Creek. This is the last tributary to enter the Nisqually River in Mount Rainier National Park. Tahoma Creek originates from the South Tahoma Glacier and is joined by Fish Creek before reaching the Nisqually River. This neighbor to the Tahoma Glacier is an interesting example of a cirque-born glacier, nourished and shaped almost exclusively by direct snowfalls and eddying winds. In spite of being exposed to midday sun, it is nearly four miles long.[48]

Tahoma Creek carries a heavy load of "glacial flour", powdered rock ground from the mountain glaciers and present in rivers that flow from active ice. A clear melt water stream is one characteristic that distinguishes a non-glacial stream from an active glacial stream.[49]

17.2 ♦ Turn left at Sunshine Point Campground. Turn right and drive through the picnic area (only 100 feet or so from the river) and then around the loop through the camping area for the best view of the Nisqually. It has grown during its decent from the glacier. In shallow stretches, especially those full of bends, the friction of the water against rock and the riverbank momentarily slow the river. In straight channels, where the waters run deep and narrow, the river gathers speed. Fast-moving water quickly erodes the banks and gradually softens the rough edges of boulders and other obstacles. It also carries greater amounts of large drift material -- rocks, sand, leaves, needles, bark, logs and silt – than do slower-moving rivers. When the waters slow, the drift material filters down and get moved aside by the current. The material collects and forms islands, shoals and bars.

Engineers have built an artificial boulder jetty along the riverbank to keep the river from eroding the campground.

9. THE NISQUALLY RIVER AT SUNSHINE POINT CAMPGROUND (R. Hixson, 11-12-99)

17.5 Exit campground and turn left.

18.0 You are exiting Mount Rainier National Park. The protected status of the park has meant limited logging within the park boundaries. Notice the difference in the size of the trees inside park (old growth) and outside (2nd or 3rd growth).

18.6 ♦ You are crossing over Tenas Creek (unsigned) another Nisqually River tributary.

19.2 ↑ On your left you can see an old logging camp (across from Alexander Inn). Large-scale logging in the area did not begin until the Tacoma Eastern Railway arrived in 1904. Before that there was no way to bring in large machinery or ship out lumber.[50]

10. OLD LOGGING CAMP BETWEEN TENAS AND GOAT CREEKS (R. Hixson, 11-12-99)

19.4 ♦ You are passing over Goat Creek, a tributary to the Nisqually.

20.5 ♦ This is Copper Creek (unsigned). It originates from Lake Christine in the Glacier View Wilderness and flows into the Nisqually River.

23.8 ↑ You are entering the town of Ashford (where there is a general store and post office). It began in 1880s with homesteads and by the 1890's scattered sawmills were added. It became platted as a town by Walter Ashford on August 7, 1904.[51] When the Tacoma Eastern Railway selected it as a terminus of its railroad, growth occurred, including a hotel that could accommodate 20.[52] A large mill at the nearby town of National provided jobs and made Ashford a sizable commerce center. In addition, the railroad provided passenger service for tourists en route to Mount Rainier. The general route of the railroad and the earlier wagon road – and the present highway – followed a trail used by native people when traveling to the Yakima country east of the mountains.[53]

The rapid development of the Ashford/National area, and its subsequent decline at the end of the timber boom in the 1940's, typifies the "boom and bust" cycle that drove many small upper watershed towns.[54]

24.0 ↑ Take a right into the parking lot of Whittaker's Bunkhouse in Ashford. In the northwest corner of the parking lot is a kiosk with information on the Native American tribes of the region, the State Trust lands, the National Forest Lands and Mount Rainier National Park.

The bunkhouse is named after Jim and Lou Whittaker, first of the postwar generation of climbers to guide on the mountain. They began guiding in 1951 and concentrated on developing routes that could utilize the cabins at Camp Muir. The twins reopened Gibraltar as a guide route in 1951 and thus virtually ended use of the Kautz route by guides.

In addition to becoming guides at Mount Rainier, the Whittakers continued to climb internationally. In 1963, Jim Whittaker was the first American to plant an American flag on the summit of Mount Everest.

25.5 **11. OLD RAILROAD TRACK NEAR NATIONAL** (R. Hixson, 11-12-99)

These train tracks were built in 1904 by Tacoma Eastern Railway. They were used mainly to haul lumber from National, a mill town located just south of where these tracks cross the highway. In 1905, National was established as a company town for the Pacific National Lumber Company. With its massive sawmill and peak population of 4,000, the town could be seen from neighboring Ashford roughly two miles away. Even though fire consumed the mill and much of the town in 1912, it failed to slow the pace of production. The mill was soon rebuilt and work continued at a brisk pace.[55] These prosperous times were short-lived. The timber boom ended in this area in the mid 1940s but not before much of the forest cover was eliminated and increased erosion occurred because of fewer trees and more roads.

In 1944, the sawmill at National was acquired by the Harbor Plywood Corporation, which, in turn, sold its holdings to Weyerhaueser Timber Company in 1957. By then neither National nor Ashford was a logging center, and Weyerhaueser soon swapped these holdings to the Washington Department of Natural Resources for other land.[56]

29.1 ↑ These rail tracks go to Mineral, a small town located near Mineral Lake. Mineral takes its name from the deposits of cinnabar in the area. Cinnabar ore is rich with mercury, which can be extracted simply by heating. The town of Mineral spreads along the shores of a mountain lake, reached in summer by an excursion steam train from Elbe, as well as by road. It has been - and is - a forest products town, known also for a two-and-a-half-story log inn built in 1906. The building is an outstanding example of log architecture.[57]

♦ Four branches of Mineral Creek join and flow downhill into the Nisqually just west of the train tracks.

31.6 This is the junction of Highway 706 and Highway 7. Stay to the right at the "Y" and you will be on Highway 7 north.

31.9 ↑ To your left are old passenger train cars. You are going through the unincorporated area of Elbe. Today Elbe is best known for its scenic steam train ride to Mineral, and a tiny but classic Lutheran church, built in 1906 to serve German settlers. In the past, a series of boarding houses and restaurants accommodated tourists and the men who worked at various small mills in the area. Fires eventually destroyed almost all the structures.[58]

12. OLD TRAIN CARS AT ELBE (R. Hixson, 11-17-99)

♦ Elbe uses nearby Alder Lake, which was created when the Alder-La Grande hydropower complex was completed, as its discharge for human waste.[59] Like many rural areas, Elbe does not have the money to build a better waste disposal system. Small towns discharge a small amount of waste and find it hard to justify expensive waste treatment facilities unless they can collaborate with neighboring areas to treat cumulative waste.

32.2 ♦ This is where the Nisqually River flows into the seven-mile-long Alder Lake.

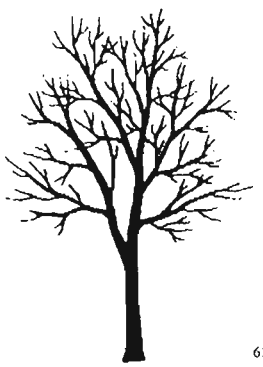
36.5 **13. STUMPS IN ALDER LAKE** (R. Hixson 08-19-01)

On your left is Sunny Beach Point (and a picnic area). This park is open in summer and allows access to Alder Lake. From here you can see the tree stumps that fill the bottom of the reservoir, remnants of what was once a low elevation forest.

During the first years after a reservoir is filled, decomposition of submerged vegetation and soils can drastically deplete the level of oxygen in the water. Rotting organic matter can also lead to releases of huge amounts of methane and carbon dioxide.[60] Fish populations can be drastically affected by these changes.

Reservoirs often 'mature' within a decade or so, which means most of the organic matter has decomposed. Thorough clearing of vegetation in the submergence zone before the reservoir is filled can reduce this problem, but because clearing is difficult and expensive, especially for large reservoirs, it is rarely done.[61] In Alder Lake, the trees but not the stumps were removed.

37.0 ↑ You are entering the city of Alder. In the early 1890s a settlement of farms began in the Alder area, so named because Alder trees dominated the scenery. With the arrival of the railroad by 1904, logging activity provided the impetus for Martin Hotes to plat the town of Alder in 1905. Alder began to serve the needs of many logging camps that stretched along the Nisqually River and along Alder Creek to Eatonville.[62]



RED ALDER (*Alnus rubra)* - Red Alder can either be a shrub 8 to 12 feet high in a thicket along a stream or a medium sized slender tree 35 to 40 feet tall. It has abundant leaves but look airy. The bark is a ghostly greenish white with dark blotches. The inner bark is brick red. Alders grow extremely fast but are not very long-lived. They were used extensively by the Northwest Coast Native Americans for woodworking, dishes and baby cradles.

The best habitat for Red Alder is banks of streams, swamps and mountain canyons in moist soils. They can grow in loam, gravel, sand and clay. They often occur in nearly pure stands.

63

Red Alder's range is from SE Alaska southeast to Central California. Except along some northern Idaho streams, Red Alder seldom grows more than 100 miles inland from the Pacific, and usually at elevations of no more than 2500 feet.[64]

37.3 Turn left into Alder Lake Park. This park offers picnicking, swimming, a boat ramp and over-night camping. Follow the signs leading toward the group campground, past the ranger station, fork left past group camping and straight ahead up a small hill to the parking area.

38.3 ♦ On your left is a sign that describes Alder Dam. Park and walk up the hill until you can see the dam. During and after World War II, the demand for energy increased and the Nisqually River was scouted to see where more dams could be built. In 1942 construction of Alder Dam began (See Figure 12). When completed in 1945, the 330-foot dam provided 50,000 kilowatts – enough energy to heat and light 21,000 homes.[66] Together with the La Grande dam, over 570 million kilowatts of power are generated annually.

	Alder	**La Grande**
Completed	1945	First dam: 1912 New dam: 1945
Type of dam	Concrete arch	Concrete gravity and embankment
Height above riverbed	285 feet	192 feet
Length	1,600 feet	710 feet
Volume of concrete in dam	420,000 cubic yards	85,000 cubic yards
Average flow	1,400 cubic feet/second	1,400 cubic feet/second
Reservoir length	7 miles	1.5 miles
Miles of shoreline	28 miles	3.5 miles
Reservoir volume	214,500 acre-feet*	2,700 acre-feet*
Average annual power generated	228 million kilowatts	345 million kilowatts

*one acre-foot is equal to 325,850 gallons

Figure 12. Hydroelectric Project Statistics for Alder and La Grande Dams

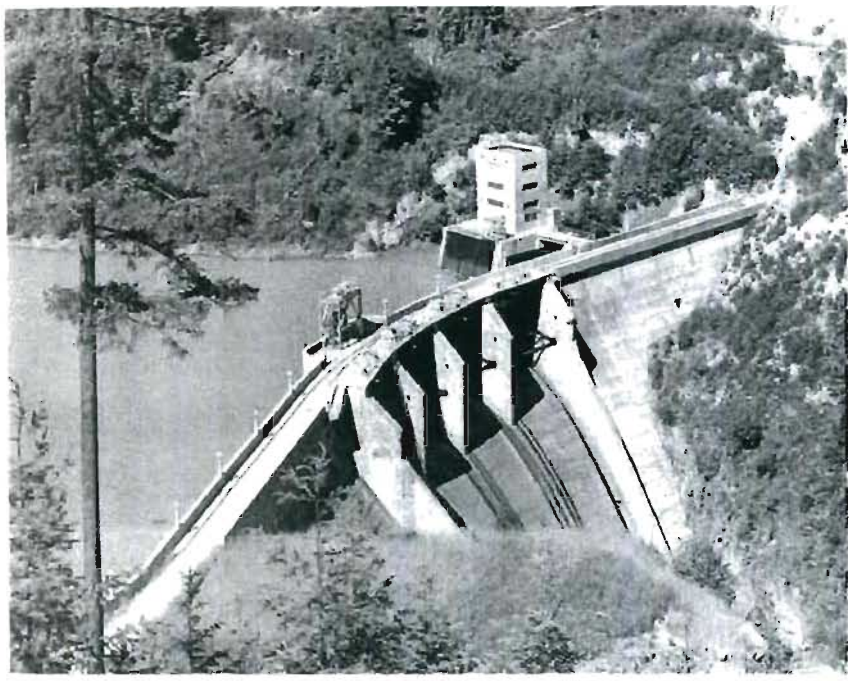
14. ALDER DAM (Courtesy of Tacoma Power)

39.5 Return to the park entrance and turn left onto Highway 7.

40.4 ♦ On your left is a turnout which has information on Alder Dam and the Nisqually Project. Looking down into the gorge you can see Alder Dam. Large-scale engineering projects on the Nisqually River started in 1910. The original La Grande Dam, constructed by the Tacoma Light Department, temporarily impounded the Nisqually River behind a 45-foot wall of concrete. Around 900 cubic feet of water per second was diverted from the Nisqually River, routed through a 1,300-foot-long settling channel, then into a tunnel more than two miles long, carved through solid rock. From there, water was carried by four large penstocks to a powerhouse below. Within the powerhouse, four sets of turbines and generators produced energy. This project took two years and $2.4 million in cash to complete, but was able to supply the City of Tacoma with all of the 20.4 million kilowatt-hours of energy the city used every year. When the La Grande Dam failed to keep up with the demand for power, it was replaced by the larger Alder dam.[67]

41.7 ♦ On your left is a turnout with a sign that describes La Grande Dam.

15. LA GRANDE DAM (Courtesy of Tacoma Power)



The Alder-La Grande hydropower complex initially provided Tacoma residents with "peak power" – extra energy for times of high electrical use. This meant regularly releasing additional water for generating electricity when demand was highest. This practice, which continued until 1968, wrought dramatic changes to the river. In some stretches, the channel was severely scoured, in others it lay nearly buried by clay and gravel eroded from its banks. Once-healthy riverbank habitats were immersed and then left to dry.[68]

♦ Today the Nisqually River above La Grande Dam is designated Class AA, a designation reserved for waters which are relatively unpolluted and undisturbed and must be given the highest level of protection. Below the dam, the river is designated Class A, which indicates excellent water quality characteristics but also permits some polluting uses.[69]

43.0 The town of La Grande exists today because of the hydro-electric complexes. On the west end of town is a huge power station that transmits the energy generated by the Nisqually River at the Alder-La Grande hydroelectric complex.

Below the dams, soil particles and microscopic green algae color the waters. The green waters then enter a narrow canyon; its walls of volcanic rock held in place by densely-packed gravel and hardened clay. After going through a second canyon, the river widens to nearly 60 feet and slows. Here begins the second section of the Nisqually River Watershed, the Confluence, where all water from the watershed flows into the Nisqually.

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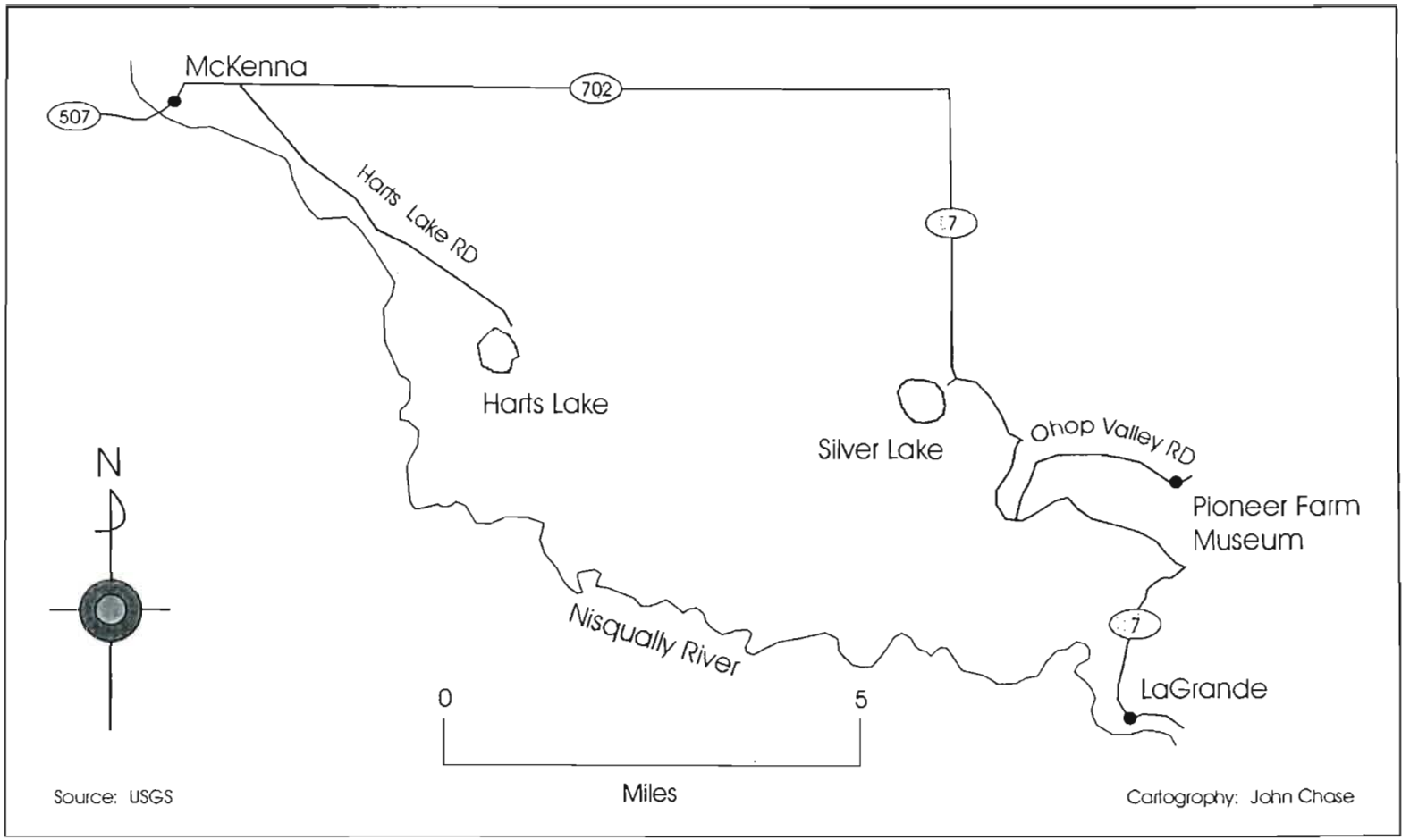
Section 2

CONFLUENCE -

Where the Waters Meet



Section 2: McKenna to LaGrande

CONFLUENCE – Where the Waters Meet

The Confluence, section two, is the part of the watershed where all its tributaries flow into the Nisqually River, increasing the river's size as it moves downstream. Since the road followed during section two curves away from the river, section two does not focus on the Nisqually River, but on land practices that are important to the health of the watershed: logging and agriculture. Both have a significant impact on water quality.

43.4 Turn right into the entrance of Charles Lathrop Pack Experimental Forest, maintained by the University of Washington's College of Forest Resources. Follow road straight and then take the first road on the left. Park in the lot by the kiosk.

16. PACK FOREST NEAR ENTRANCE (R. Hixson 11-17-99)

Charles Lathrop Pack donated $9,222 to the University of Washington on January 9, 1928 to start this demonstration forest. Pack Forest provides a field location where faculty, staff and student can teach, study, conduct research, and demonstrate modern forest management.[1] Early research at Pack Forest focused on planting, with college student helping to install plots of Western Red Cedar, Douglas-fir, Ponderosa Pine and Port Orford Cedar. Currently spread across more than 4,000 acres, the experimental forest contains many native and non-native tree species.[2]

There are many trails to hike, drive or bike. A seven-mile drive looping through the forest is open daily, except weekends and during deer-hunting season; entry on foot is permitted even when the road is closed. Highlights include an arboretum and a grove of old-growth Douglas-fir, a cascading waterfall on the Mashel River, and – from Hugo Peak or High Point, accessible by road or trail – an outstanding view of Mount Rainier. Just inside the entrance is a walk-through model of the watershed built at a 1:100 scale. A map of the area can be found at the gatehouse. An interpretive center beyond the gatehouse explains research underway in the forest.[3]

17. OUR CHANGING FOREST TRAIL – STOP 5 (R. Hixson 11-17-99)

To get to two small hiking tours, drive straight for 0.1 miles until you reach the sign that says "Changing Forest - Self-Guided Trail". Turn left into the parking area. Near the Biosolids information kiosk is **"Our Changing Forest Self-Guided" Trail.** Walk this ½ mile (roundtrip) self-guided trail to learn about the life cycle of a Douglas fir forest. The trailhead lies just northeast of the Biosolids Demonstration Area at the end of a small road.

A booklet at the trailhead gives information about each of the eight stops on the trail. While you walk the trail and read about the history of this forest, be sure to watch for animals common to Douglas-fir forests: Northern Flicker, Douglas' squirrel, and Pacific chorus frog.[4] Time: 20 min.

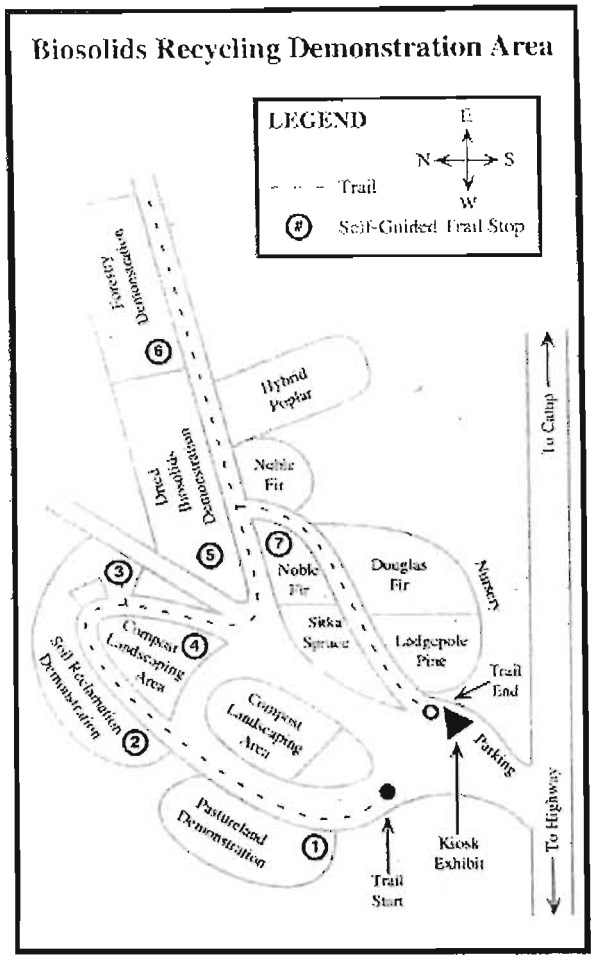


Figure 14. Biosolids Recycling Demonstration Area Map.[7]

You can also tour the **Biosolids Recycling Demonstration Area.** See how the solids flushed down the drains are treated and turned into fertilizer for forests, gardens and agricultural land. The area includes "The Biosolids Story" exhibit and a ¼-mile, self-guided loop trail entitled "Recycling a Resource" (Figure 14). A pamphlet at the beginning of the trail guides you through the exhibit. Time: 15 minutes.[5]

There are many other hikes available in the forest. See **Figure 15** for location of trails.[6]

Hugo Peak Trail – Trek to the top of 1,740-foot Hugo Peak. From here you have views of the Mashel and Ohop valleys, the Olympic Mountains and the Issaquah Alps. Piece together clues from the forest to understand the ecological and management history of this trail. Distance: 4 miles. Time: 2 ½ hours.

Trail of the Giants– Experience a 200+-year-old forest stand and learn how this ecosystem is unique. One-mile round trip. Time: 45 minutes.

Tacoma Eastern Railroad Grade – A one-mile walk along an abandoned grassy railroad grade. Time: 30 minutes.

Pack Forest Driving Tour – Observe forest demonstration areas showing timber harvest patterns, reforestation, wildlife habitat enhancement, old growth forests and research projects.

Windy Ridge Trail – A one-mile (round trip) hike along the edge of recently harvested Douglas fir stands (summer 1996) to an acid rain testing station. On clear days you will be treated to a spectacular view of Mt. Rainier. Time: 45 minutes

Reservoir Trail – A two-mile (round trip) trail travels through an old growth stand, into a young Douglas fir stand, and then through a naturally-seeded second growth forest. Time: 1 ½ hours.

Falls Trail – A 1.5-mile (round trip) hike to three waterfalls. After passing through young Douglas fir stands at the edge of a meadow, the trail descends into an alder stand, and winds along the Little Mashel River. The path forks, allowing you to hike to the Upper Falls, or continue down to the Middle and Lower Falls. Time: 1 hour.

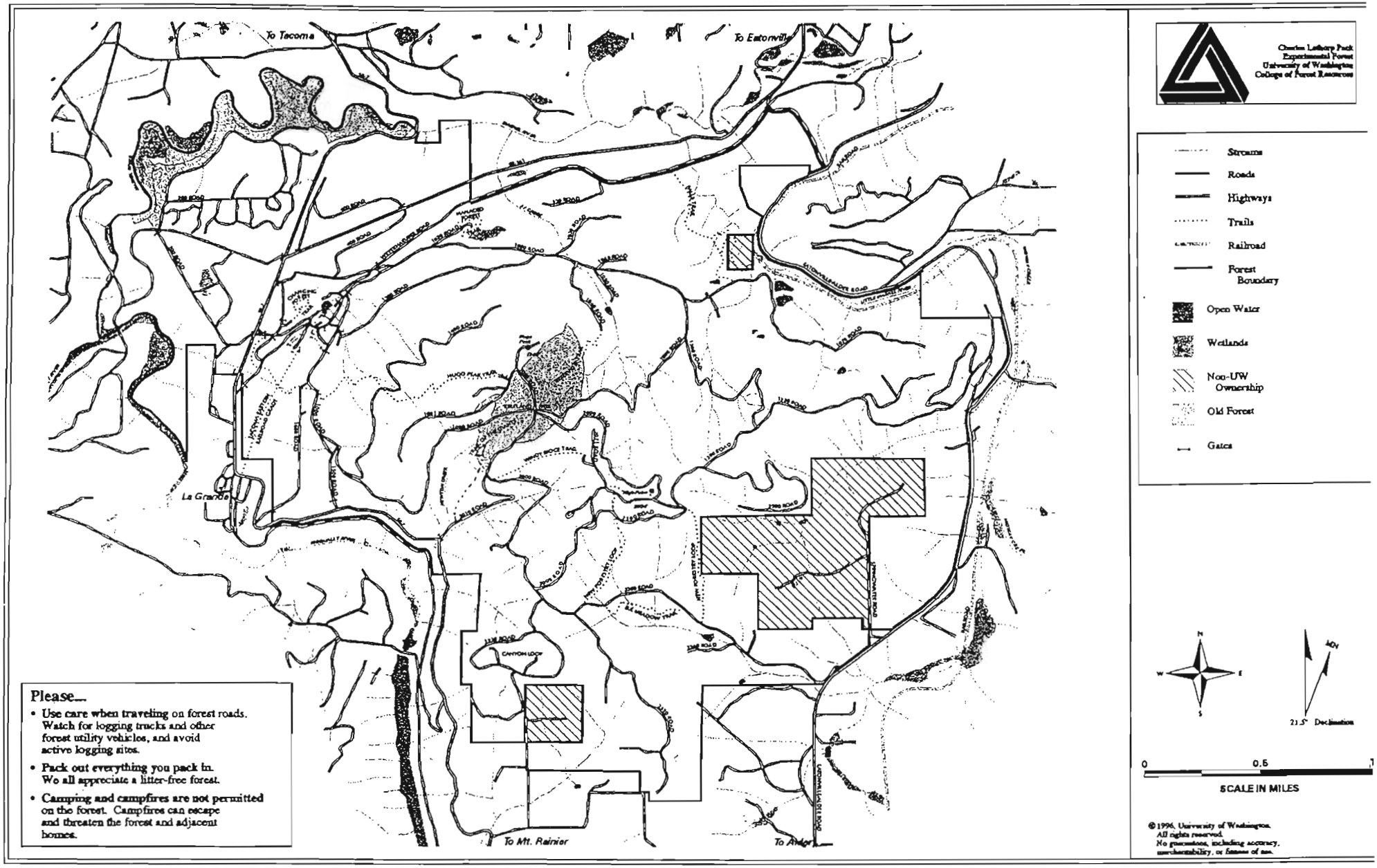


Figure 15. Map of Charles Lathrop Pack Experimental Forest.[8]

New Forestry/Elk Meadow Loop Trail – This two-mile hike will take you through "new forestry" timber harvest (replanted in 1990), in which several features were left during logging to enhance use by wildlife. Notice large logs left on the ground as habitat for small mammals, and snags left for birds of prey to perch in while hunting small mammals, and as homes for cavity-nesters. You will walk through a mixed conifer and deciduous forest and into a meadow that was the site of a turn-of-the-century logging camp. Time: 2 hours.

For more information visit the forest office at the front entrance from 8am-5pm, Mon-Fri. Call (360) 832-6534, or write to Pack Experimental Forest, University of Washington, 9010 452nd St East, Eatonville, WA 98328.

Leave the forest the same way you drove in.

43.7 Turn right, back onto Highway 7.

44.6 Notice the clear cut on the right. Logging continues to shape the identity of the middle watershed, although the actual practice of harvesting trees has changed over the years.

18. **CLEAR CUT SOUTH OF MASHEL CREEK** (R. Hixson, 11-17-99)

Nearly two-thirds of the watershed's acreage is timberland, owned and managed by a range of interests – including the U.S. Forest Service, Washington State Department of Natural Resources, University of Washington, Weyerhaeuser, Murray Pacific, Champion International, Plum Creek, the Nisqually Indian Tribe, and the U.S. Army.[9]

The first loggers in the Nisqually River watershed could afford to remove the biggest, straightest and best timber and leave the rest. After taking the most desirable resources in one part of the watershed, work crews simply moved on to the next. Little thought was given to replanting these harvest sites or stabilizing the freshly exposed forest floor. These early operations allowed wind and rain to erode the top layers of soil, which often washed from the land into the Nisqually's tributaries. Here it smothered salmon eggs and damaged fish and wildlife habitats.[10]

A significant change took place near the turn of the century. Foresters began to take steps to ensure a second harvest. Over the past two decades, federal and state regulations and private work standards have improved logging operations along the Nisqually River and it tributaries.[11]

45.0 ♦ Below is the Mashel River (unsigned). Fed by the Little Mashel, a tributary that collects water from 25 square miles, the Mashel River supplies much of the Nisqually River's instream flow. Past forestry practices severely damaged the Mashel River because its narrow channel left it vulnerable to human impacts as well as natural disturbances. Historically, the Mashel's uppermost reaches have been alternately scoured by flash flooding, and buried by silt and woody debris from logging operations.[12]

Although many changes have been made to improve the water quality of the Mashel, the City of Eatonville still discharges its municipal sewage effluent into the Mashel River, which ultimately finds its way into the Nisqually River.[13]

46.6 ⛴ On the left is a forest planted by Weyerhaeuser in 1982. Even though harvested forests are being replanted, it takes many years for the new trees to perform the same functions older trees did, such as retaining water and providing habitat. Also, the trees that are planted after logging are usually monolithic stands of Douglas fir. These forests do not have the same diversity of plants and animals as "natural" forests.

47.3 🍽 Turn right onto Peterson Road (may be unlabeled) and follow signs to Ohop Valley Road. Follow the road until you see Pioneer Farm on the right. While most of the Ohop's original farm families left the valley long ago, their legacy lives on at the Pioneer Farm Museum.

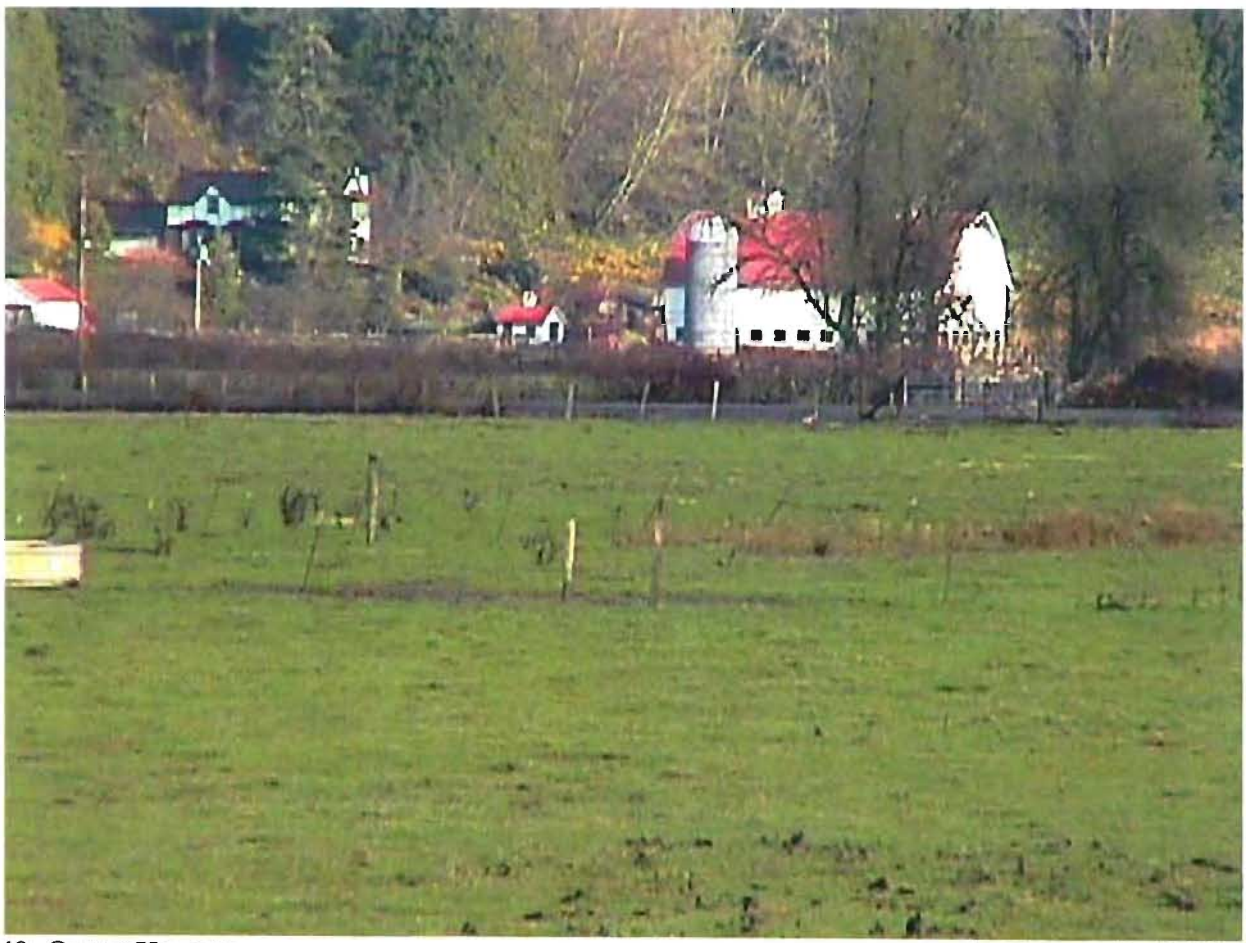
Among the intriguing features of this interpretive center is a pair of homesteaders' cabins and a trading post. Built in the 1880s, all three were moved to Pioneer Farm and restored. The old "Trading Post" is a family cabin built in 1887. Items to trade for money included toys, bonnets, candy, books, rabbit furs, etc.[14]

At the farm, visitors can jump in the hayloft of a barn, pound horseshoes at a blacksmith's forge, churn butter or use a spud to remove bark from a log. A Nisqually longhouse shelter has demonstrations of native crafts, and a hatchery on the Mashel River presents the story of salmon, from native tales of the dream-time when people and animals were one, to the present-day need to restore the spawning runs of overfished rivers and creeks.[15]

Although the activities are mostly aimed at kids, the Nature Trail tour provides an education on how natural resources continue to give life to our planet. The guide will tell you what people in the area have been doing to make sure those natural resources are used wisely.[16]

48.6 To continue the trip, follow the same route back to the highway and turn right onto Highway 7.

48.8 ↑ You are entering the Ohop valley. In 1874, Robert Fiander filed a homestead claim in the Ohop valley making him the first settler in the region.[17] Gradually, homesteads stretched from one end of the valley to the other: from Nisqually River to Ohop Lake. Land clearing, reclamation and road building were completed before the settlers could farm much of the valley. Traces of the reclamation work can be seen on the valley floor. Ohop Creek is the first body of water you pass over, but the next small "stream" is a canal dug by the Scandinavians settlers to drain the valley in order to farm it.[18]



19. OHOP VALLEY (R. Hixson, 11-17-99)

♦ Lynch Creek and Ohop Lake feed Ohop Creek. Recently, the temperature in Ohop Lake has risen, which could produce problems downstream in the future. Community members think this problem has to do with decreased runoff reaching the lake, and runoff from farms that has altered the chemical balance in the lake.

Private interests own much of the land, from the lake to the valley floor. These community members are making efforts to maintain the forests they own and find as many ways as possible to improve water quality. Agricultural practices still affect the Ohop Valley, even though farming in the Nisqually River watershed is changing.[19] Large commercial farms are being converted to small, non-commercial operations, commonly known as "hobby" or part-time farms. The combined effects of these small farms on water quality may be greater than those of continually-managed, commercial operations 25 acres or larger. Part-time farmers often lack the experience, training and space to put pollution controls in place. A 1994 inventory of farms in the Mashel and Ohop Creek drainages found half of the farm operations were on less than 10 acres. The highest animal densities were found on the smallest farm sites.[20]

Overcrowding puts pressure on pastures and livestock, and compromises water quality. Nutrients from animal waste that wash into rivers and streams can lead to an imbalance in the natural nutrient cycle, robbing fish and other aquatic life of the oxygen they need to survive. Animal wastes are also sources of pathogens harmful to human health. Along with pesticides and petroleum products, easily washed from farmlands into the Nisqually whenever it rains, pathogens pose a threat to the health of people living downstream.[2]

Community members, along with help from several state and federal organizations, are helping area farmers and livestock owners learn to protect the environment. One program helps farmers erect streamside fences to keep livestock from trampling banks, and another works with farmers to ensure proper handling of herbicides, pesticides and fertilizers.

The Pierce County Conservation District (PCCD) is helping the residents of the Ohop Valley keep the Nisqually River clean. In 1996, PCCD completed work on the Washington Conservation Commission Grant for the Ohop Creek/Mashel River Subwatershed, and an EPA 319 Grant. Through these grants, landowners within the Nisqually watershed have been assisted with small farm, private forestland, and streamside conservation efforts. Potential sources of non-point pollution have been reduced within the Nisqually watershed through assistance to landowners. Conservation plans for small farms are being written, and best management practices are being designed and implemented.[22]

Small farm owners have the opportunity to attend a management workshop held at a five-acre farm in the Muck Creek area. They learn about practices that conserve natural resources and increase farm productivity, and have a chance to see the practices implemented.[23]

Forest owners can participate in the Forest Stewardship "Coached Planning" short course offered by PCCD in conjunction with the Washington Department of Natural Resources. This series of workshops enables landowners to become more informed decision-makers about their land, and to write their own conservation plans.[24]

51.1 ♦ Take a left at the turnoff for Silver Lake. Go 0.1 mile to an intersection and turn left. Follow this road 0.1 mile to the public boat launch. Notice how much development has occurred around the lake. Water from the lake, carrying runoff from surrounding houses and development activities, runs into Kreger Lake and then into the Nisqually River.

To continue the trip, go out the way you came in and turn left onto Highway 7.

20. SILVER LAKE (R. Hixson, 11-12-99)

54.9 This is the junction between Highway 7 and Highway 702. Turn left onto Highway 702.

The numerous small hills and valley across the plains were formed by mudflows. The mudflows created elevated areas not subject to flooding or wetlands. Species that will not tolerate having their roots submerged in water were then able to colonize these areas. As you drive from the 7/702 junction to Yelm, notice how the types of trees vary depending on their location on these mudflow-formed hills.

55.5 There are stands of second- or third-growth Douglas fir on both sides of the road.

57.8 Farming is still an important activity in the region. Many pastures in the area appear overgrazed, a common problem for farmers who own small amounts of land and are not able to rotate their livestock from field to field. Many of these small farm owners face the same problems as the Ohop Valley farmers described above.

21. FARM ALONG HWY. 702 BEFORE HARTS LAKE ROAD (R. Hixson, 11-12-99)

63.6 On your left is Harts Lake Rd S. Follow this road to Harts Lake.

68.0 🍽 Notice Wilcox Farms to your right. This large dairy farm sits on the west edge of Harts Lake. The first Wilcoxes came from Canada by way of Pennsylvania sometime between 1900 and 1910.[25] Do not turn on the road leading toward Wilcox Farms. Continue straight ahead.

68.4 At Templin Road S, veer right and follow the signs to the public fishing area and the boat launch.

68.9 ♦ Harts Lake water has only a short way to go before it reaches the Nisqually River. At the boat launch, notice that the lake is much less populated around its shores than Silver Lake, perhaps because it is farther away from densely populated cities. From the boat launch you can see all white buildings of Wilcox farms across the lake.

Although trees surround much of the lake, it is second-growth forest. The old-growth forest was logged beginning in 1915. By 1921, huge logging camps were set up on Harts Lake.[26]

22. HARTS LAKE, 1915

(Martinson & Magden, 1984)

23. HARTS LAKE, 1999

(R. Hixson, 11-17-99)

↑ Some of the first settlers to the area were Sophia and Benjamin Horsfall. They immigrated from England, then came to Washington Territory by way of Illinois in 1887. The Horsfalls became the first permanent homesteaders on "the point", the north hillside of Harts Lake. Six new families followed, and by the late 1890s a small schoolhouse with rough siding was built near the top of Bennett Hill.[27]

Between 1900 and 1910, more settlers arrived. While many of the fourteen families had moved several times on their way west to Washington State, all of the settlers stayed permanently at Harts Lake except for the Ravnums, who sold to the Wilcoxes. With the arrival of new settlers, Sophia Horsfall pushed to have a new school built. In 1905, her dream came true. The new school had three layers of planed lumber instead of a single planked floor, the walls were planed and painted and water was piped in. Harts Lake School was larger than most rural schools, better designed, and more attractive.[28]

69.3 Go back out Templin Rd and turn left onto Harts Lake Rd to 702.

74.2 Turn left onto Highway 702.

74.8 ↑ You have entered McKenna. Turn left at the light onto Highway 507 South toward Yelm.

The town was named for E.W. McKenna, vice-president of the Chicago, Milwaukee and St. Paul Railroad that ran trains near Yelm. McKenna was a "company town" since everything was owned by the Salsich Lumber Company.[29] In 1906, construction of the sawmill and lumber planing mill was started. The Salsich Lumber Company moved it offices from Tacoma to McKenna in 1908 and by 1909, the mill was one of the largest in the nation to have all its operations under one roof. Logs from Harts Lake and Cougar Mountain were shipped down to McKenna. At its peak, there were more than 220 employees working at the mill. The log mill shut down in 1929, and the planing mill in 1930, ruining the backbone of employment in the region.[30]

75.2 ◆ You are now passing over the Nisqually River again. At this point, the river has received water from over 20 tributaries and 9 lakes.

24. **NISQUALLY RIVER NEAR MCKENNA** (R. Hixson, 08-19-01)

The road will again follow the river as it heads downstream into the third part of the Nisqually watershed, the Delta.

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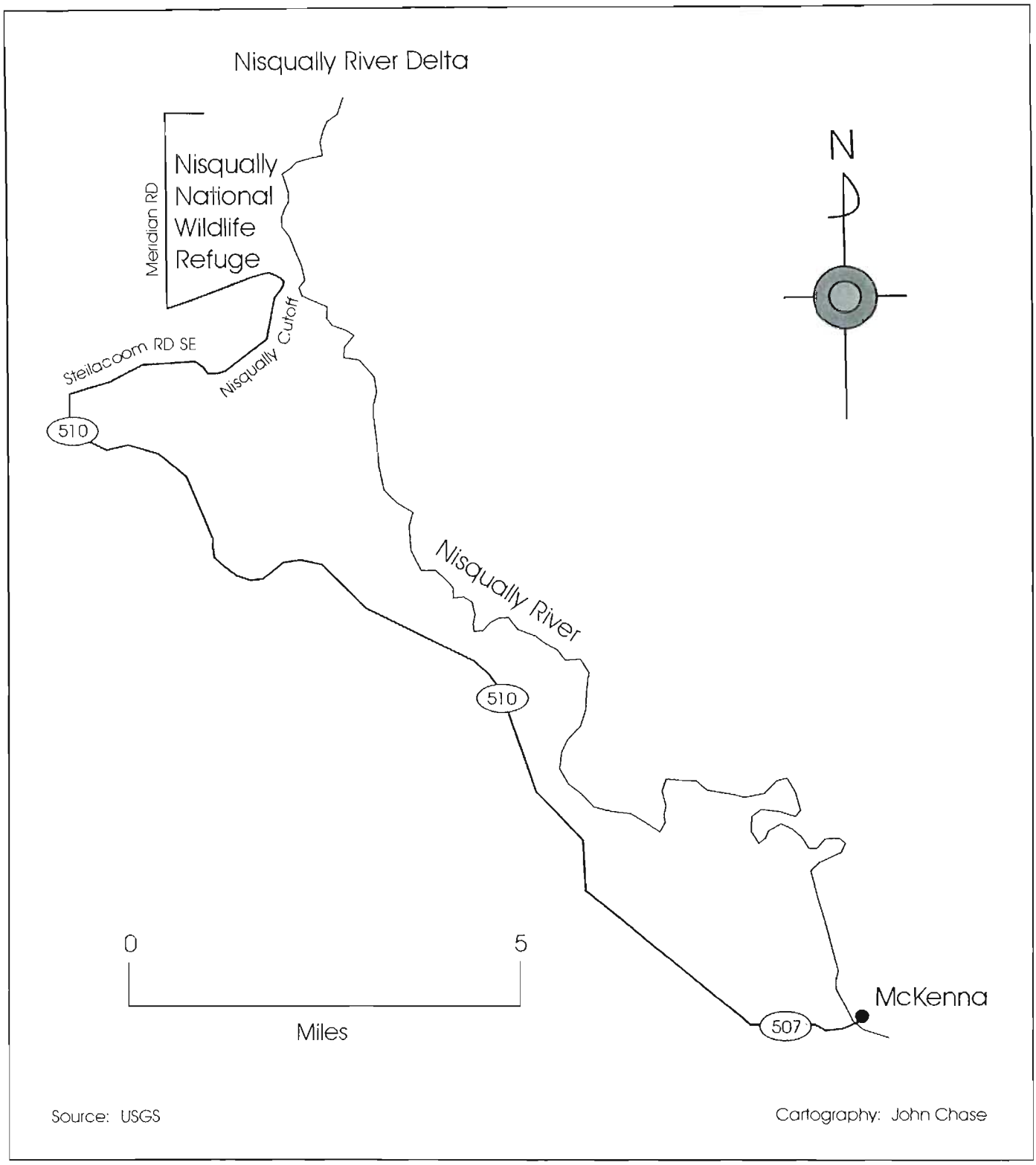
Section 3

THE DELTA -

Life in the Lower Watershed



Section 3: Nisqually River Delta to McKenna

THE DELTA - Life in the Lower Watershed

76.0 ↑ You are entering the town of Yelm, which is located in the lower watershed. Continue through the town until the third light, which will lead to Highway 510.

This area is comprised of rolling prairie lands, the Nisqually River Delta and the Nisqually Reach. The features of the Lower Watershed were created about 15,000 years ago, at a time when much of southern Puget Sound lay beneath the Vashon Ice Sheet. As this giant sheet of ice retreated, it left behind a sparse, flattened landscape filled with potholes and coarse, gravelly soils. As the glacier melted, water seeped through the ground, feeding into the watershed's principal aquifer.[1]

Over time, grasses and low-growing plants covered the prairie, and trees sprouted on the perimeter. The native people, who managed the land by setting fire to the prairie, kept the steady encroachment of trees onto the prairie in check. Intentional burning drove elk, deer and other game into hunting range and helped give the competitive edge to perennial bunchgrasses, food for horses. Fire also enhanced the production of camas, a flower whose bulbs were steam-baked and eaten.[2] When James Longmire saw the prairie in 1853, he wrote "We crossed the river and went to Yelm Prairie, a beautiful spot, I thought, as it lay before us covered with tall waving grass, a pretty stream flowing though it, bordered with shrubs and tall trees, and the majestic mountain".[3] Grassland ecologists believe that only a third of the watershed's historic prairie acreage has survived.

25. PRAIRIE NEAR YELM (R. Hixson, 11-23-99)

With fire to aid its development, individual prairies were reportedly fifteen to twenty miles long and nearly as wide. As settlement in the area began and intentional burning stopped, the forest began to creep in and opportunistic species took over. The parts of the prairie that had not been altered by plants were changed by subsequent land use practices.[4] Horses, cattle, and sheep grazed on the prairie and farmers plowed it under to plant crops. As more people came to Yelm, homesites replaced prairie lands – an easy conversion on the fairly flat, treeless plain.[5]

♦ The first permanent settlers were George Edwards and a "Mr. Edgar", Englishman who married Native American women. In 1853 the first party which succeeded in crossing the Cascades north of the Columbia River reached the area. By the mid-1850's Yelm was a tiny sheep-ranching and crop-farming settlement. After the turn of the 20th century, when the Portland-to-Tacoma railway was completed, Yelm was linked with larger, more distant commercial markets.[6]

As population increased, so did the demand for water. Soon measures were taken to ensure a better water supply.[7] Although the Yelm Irrigation Ditch project, completed in 1916, was a boon for the people of Yelm, it destroyed much of the prairie because the prairie's natural freshwater supply was rerouted and large areas of land were plowed up. Until the early 1950s, this project diverted water from the Nisqually River and channeled it into a long earthen ditch, where water was appropriated by area farmers.[8] The immediate result was 5,000 acres of prairie converted to pasture and commercial berry patches. Although no longer in service, sections of the Yelm Irrigation Ditch are still visible today, a memorial to its builders and the prairie they displaced.[9]

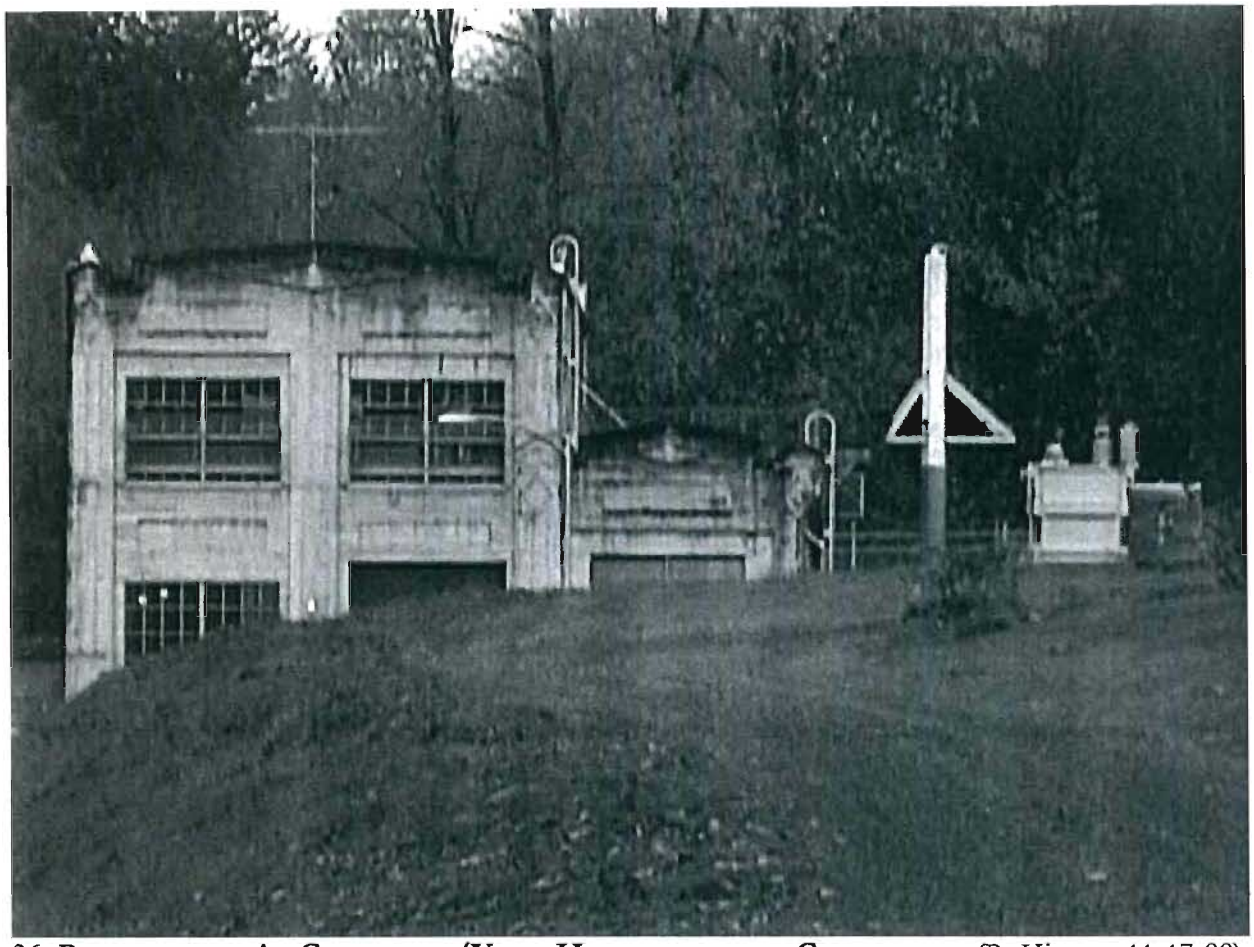
♦ Today, with its water projects, the City of Yelm has taken another course. Recently, it began to implement alternative sewage disposal technologies aimed at minimizing river impacts. Yelm's sewage treatment plant began discharging 300,000 gallons a day of sewage effluent to the Nisqually River in December 1993. In an agreement between Yelm and local conservation groups, the city removed its Nisqually River backup outfall in 1996, and limited the use of its primary outfall, which discharges to the river's power canal, in 1998. Yelm plans to improve the wastewater treatment process so that the majority of the wastewater may be applied to land rather than disposed of in the river.[10]

77.6 At the third light, go straight onto Highway 510.

80.1 ♦ Turn right and follow the road down to Yelm/Centralia Hydroelectric project. You will soon see an abandoned set of locks on your right and an old drainage channel on your left.

80.9 ♦ Park in the parking lot at the hydroelectric project and walk over to get a good view of the old powerhouse and the Centralia Dam (picnic sites available). The City of Centralia Light Department completed this hydroelectric project in 1930. This dam influenced parts of the watershed as far as 14 miles downstream. Periodic water releases from the Centralia project have piled up gravel and rock, creating a large delta that today reaches halfway across the Nisqually River.[11]

Alder Dam, La Grande Dam and the Centralia Dam have all affected fish populations. In the first years of operation, Centralia's diversion dam lacked a fish ladder and fish screens. Nothing was done to change this until the facility was renovated in 1955, at which time fish ladders and protective screens were added. In 1975, the Nisqually Indian Tribe sued the City of Centralia, seeking further restitution for the runs damaged by the diversion dam operation. A similar petition a year later sought to undo the harmful affects of Tacoma's Alder-La Grande operation.[12]



26. POWERHOUSE AT CENTRALIA/YELM HYDROELECTRIC COMPLEX (R. Hixson, 11-17-99)

Go back and exit the project area following the road you came in on.

81.7 Turn right and continue on Highway 510 toward Lacey.

82.9 ↑ Soon after you exit Yelm, you pass part of the Fort Lewis Military Reservation (unmarked). Fort Lewis began in January 1917, when a bond issue financed the purchase of 70,000 acres of land to give to the U.S. Army. Weyerhaeuser provided 73 million board feet of lumber to build Camp Lewis. Fifty miles of roads, a drill field three miles long, 1,700 buildings and 400 other structures were built. After World War I the army chose to convert the camp into a permanent facility, and in 1927 Camp Lewis became Fort Lewis.[13]

Fort Lewis Military Museum was established to collect, preserve and exhibit the history of Fort Lewis. The Museum is open Wednesday through Sunday from 12 to 4 p.m.

The north parts of Fort Lewis Military Reservation are the troop training grounds and artillery ranges. Periodic shelling and the maneuvers of U.S. Army tanks and foot soldiers, which inevitably impact the environment, have proved less disruptive to the prairie environment than irrigation, home building and unrestricted foraging by cattle and sheep.[14]

Some of the Army's activities may have unintentionally led to improved prairie conditions. For example, occasional brush fires on the 7,000-acre Artillery Impact Area slowed the invasion of Douglas-fir and Scotch broom. At other sites the Army has taken a proactive stance, working cooperatively with the Washington Chapter of The Nature Conservancy to hand-pull invasive weeds. Each year, prairie ecologists for the Army supervise the planned burning of roughly 2,000 acres of prairie.[15]

Surrounding Fort Lewis' 12,000 acres of prairie are several prime examples of oak and oak-conifer stands, plus the only extensive ponderosa pine forest found west of the Cascade Mountain Range. Some of these trees are believed to be at least 250 years old.[16]

27. MILITARY MANEUVERS AT FORT LEWIS (R. Hixson, 11-23-99)

83.9 You are entering the Nisqually Indian Reservation. The Nisqually people of the early nineteenth century spoke a dialect of the coastal Salishan language. They lived in cedar plank houses and were skilled at fishing and woodworking. The river valley and tidelands provided a varied and abundant diet.[17] The Nisqually traded and intermarried with other Native American nations and held frequent potlatches to feast and socialize with neighboring people.[18]

To the Indians, Mount Rainier was Tahoma, or "Snow Mountain". Out of respect and awe, Indians hunted on the lower slopes only, not daring to approach the summit. A myth of the Nisqually personifies Mount Rainier as a Monster Spirit, who sometimes spewed out her venom in

great torrents. This was the Native Americans' explanation for occasional volcanic mudflows that roared down the mountain, filling valleys and overspreading lowlands.[19]

In 1833, The Hudson Bay Company, a private company chartered by England, built a trading post on high land northeast of the Nisqually River Delta. Fort Nisqually was the first white settlement on Puget Sound. Dr. Tolmie, who headed the post, became good friends with Leschi, a Nisqually leader.[20]

Prior to the establishment of the reservation, the Nisqually lived in and made use of the area from the mouth of the Nisqually River to Mount Rainier, primarily along the river bottom. They also used the area along the middle and upper courses of the Puyallup River.

But in 1854, Leschi went to negotiate a treaty with Governor Isaac Stevens. Treaty-making was deemed necessary by the whites because of the arrival of American settlers, who were staking claims to the rich farmland adjoining the lower Nisqually River. This was Territorial Governor Isaac Stevens' first meeting in western Washington, and in just two December days he persuaded 662 assembled natives to cede two and a half million acres. The Nisqually left with only three small patches of land. Reservations for the Nisqually and Puyallup tribes were each to be 1,280 acres. Squaxin Island was reserved for all the other native people of southern Puget Sound, since Stevens' instructions had been to create as few reservations as possible. Furthermore, the federal government was to have a right to move people at any time, "if necessary." In exchange for their land, the tribes were to receive schools and instructors, a doctor, carpenters and a smithy, and were to retain exclusive fishing rights on their reserved lands as well as rights to fish and hunt "at all usual and accustomed places" off the reserved lands.[21] Resentment over the Medicine Creek Treaty terms led to war between natives and whites in 1855 and 1856.

Life as the Native Americans knew it had changed from the time the British first came into the area until the beginning of reservation life – a period of about 25 years. With the coming of the Americans in the last segment of that period, the changes became more drastic.[22] This period was one of staggering physical and social dislocation. The economic system they had followed for generations was torn apart by the introduction of agriculture and the availability of wages -- or at least subsistence -- in service to newcomers who were not chiefs. Mystifying diseases killed many. Missionaries had talked of a form of power previously unknown. Treaties proposed a whole new basis for daily life.[23]

At the close of the Puget Sound War in 1856, both the Nisqually and Puyallup tribes received larger reservations. The Medicine Creek Treaty had granted the Nisqually only forest land away from the river delta; the new Nisqually Reservation included river frontage for fishing and prairie land for grazing horses (which the tribe had even before the coming of whites, an unusual acquisition for saltwater natives). The new reservation land totaled 4,700 acres, nearly four times the previous stipulation. Holding more than a fragment of the land proved impossible, however. In 1917 Pierce County took nearly three-fourths of the Nisqually Reservation for inclusion as part of the Fort Lewis military reservation. The pretext was that the tribe was not using the land.[24]

Keeping fishing and hunting rights also proved difficult, although all Washington State treaties each included the same words; in exchange for land, natives were to fish and hunt "in common with all citizens." But as human population grew and wildlife diminished, the rights became a troublesome issue. Whites generally supposed the treaty meant equality for all, a per capita apportionment of

whatever fish or game existed. Native people -- and the courts -- saw the meaning as part of a contract between two parties, the federal government and the tribes whose representatives signed the treaties. In 1974 U.S. District Court Judge George Boldt ruled that the state must manage salmon so that native people have an opportunity to catch "fifty percent of the runs traditionally fished by treaty tribes." The U.S. Supreme Court upheld the Boldt decision. Emphasis now has largely switched from confrontation between natives and whites to cooperation; rebuilding the overfished, woefully mistreated salmon runs will mean more fish for everyone.[25]

The Nisqually Reservation today is only 1,650 acres. Housing projects assure homes for a large segment of the tribe. A tribal center includes a library, senior citizen facility, law enforcement building, and natural resource division to protect and improve the fish resource.[26] The Nisqually have utilized a variety of economic resources as the availability of natural resources declined. Now a casino borders the main road leading through the reservation.

84.8 ♦ The Nisqually Indian Natural Resource Department is on your left. The Nisqually have played a key role in bringing the importance of salmon management and river protection to the community. They constructed their own hatchery in 1977, the Kalama Creek Hatchery, which was designed to bolster sagging coho and Chinook runs. They also began a program to "plant" fingerlings of chum salmon in Yelm Creek and in years of low flow, Muck Creek.[27] They have also been very active in working with the Washington Department of Fish and Wildlife to mark hatchery fish. Mass marking is a technique used to distinguish hatchery-produced Chinook and coho salmon from wild fish. Hatchery fish are marked by removal of the adipose fin, a small fin on the fish's back near the tail.[28] Marking offers anglers an obvious way to tell if a fish is a hatchery fish, which may be kept, or a wild salmon, which must be returned to the water. Marking allows fishing to continue on hatchery stocks, while protecting wild fish in waters where the two stocks intermingle.[31]

Mass marking has been used by the Department of Fish and Wildlife since 1996 for coho. In 1999, 35 million coho were marked. In addition, the Department began marking Chinook, and marked 13 million Chinook statewide, including 10 million Puget Sound Chinook.[29]

Until recently, all marking was done by hand. To mark a larger number of fish, the Department of Fish and Wildlife began to use an automated fish marking system. The new mass marking machine is housed in a trailer which can be moved from one hatchery to another when marking is underway. The marking machine, which can mark 7,000 fingerlings per hour, or two fish per second, uses a flow of cold water to attract fish to a chute where mechanized gates separate them and hold them for individual fin clipping. A tiny camera and special software helps position the clipper and verifies that the adipose fin is removed.[30]

85.5 Continue straight on Highway 510 west toward Lacey and Olympia.

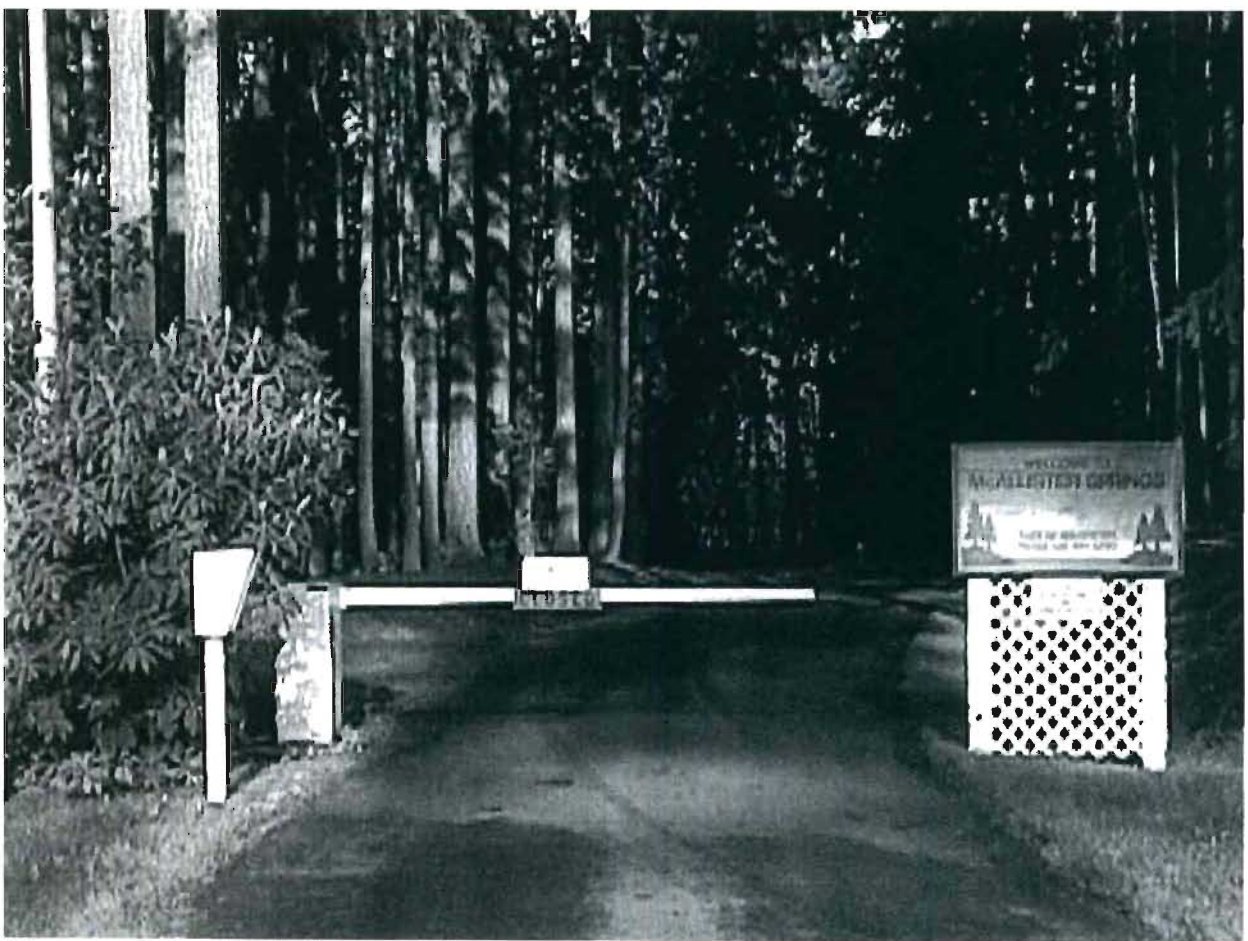
86.1 ♦ You are now entering a Wellhead Protection Area. Wellhead protection programs are designed to protect groundwater by regulating land use affecting the aquifer. Much of the water for Lacey, Tumwater and Olympia comes from aquifers that are fed from runoff in this region.

88.4 Take a right at the "Y" and head toward Nisqually. Notice the signs posted on the trees on the left side of the road, which indicate that this watershed supplies the City of Olympia's drinking water.

88.8 Turn left at McAllister Springs. The springs can be toured by appointment only. Call (360) 491-0750 in advance.

♦ McAllister Creek, which is fed by the springs, used to be called Medicine Creek. Although it does not run into the Nisqually, its waters run through the Nisqually Wildlife Refuge, feeding the estuary there.

McAllister Springs was named after James McAllister, a Nisqually Flats settler and a friend of the prominent Nisqually leader Leschi. When Acting Governor Charles Mason wanted to find Leschi in October of 1855, McAllister and his friend Michael Connell volunteered to scout the prairie for Leschi. The two men set out on October 27 and never returned. Some friends found their bodies lying in a swamp. None of the soldiers in the area had seen the shooting. The assailants were never identified. On October 31, Colonel A. Benton Moses and Joseph Miles were killed as they escorted a messenger along the road to Fort Steilacoom. Leschi was blamed and the Puget Sound War began.[32]



28. ENTRANCE TO MCALLISTER SPRINGS (R. Hixson, 11-23-99)

89.3 After the springs, return to the route by going right onto Highway 510.

91.4 At the stop sign, take a right onto Marvin Road. Follow signs for Highway 510 and I-5.

91.8 Turn right onto Steilacoom Road. After one mile there will be a stop sign. Continue straight ahead.

93.9 ♦ On your right is McAllister Creek and the McAllister Fish Hatchery, which was built in 1977.

The Washington Department of Fish and Wildlife (WDFW) operates the largest network of hatcheries in the world, producing salmon, steelhead, trout and warm-water fish (bass, perch, catfish and walleye).[33] The first salmon hatchery in Washington was built along the Kalama River in 1895. The state's first trout hatchery was constructed in 1903 on Lake Chelan. In 1997, Phase I of the state's first warm-water hatchery was completed in Eastern Washington.[34] The original purpose of salmon and steelhead hatcheries was to restore dwindling commercial and recreational catches of fish. Trout and warm-water hatcheries are designed to increase recreational opportunities for the public. Hatcheries were also used to make up for lost production caused by development, primarily hydroelectric dams.[35]

The first salmon hatcheries in Washington were owned and operated by commercial canneries, counties or even townships. Because there was no holistic approach to fish husbandry, fish culture techniques and production decisions were often inconsistent. Today, hatcheries are used to increase fishing opportunities, restore declining runs of fish, and manage gene pools. Hatchery practices continue to evolve with scientific advances, the concerns of Washington's citizenry, court ordered mandates to share the harvest, and mitigation for natural fish production lost to development.[36]

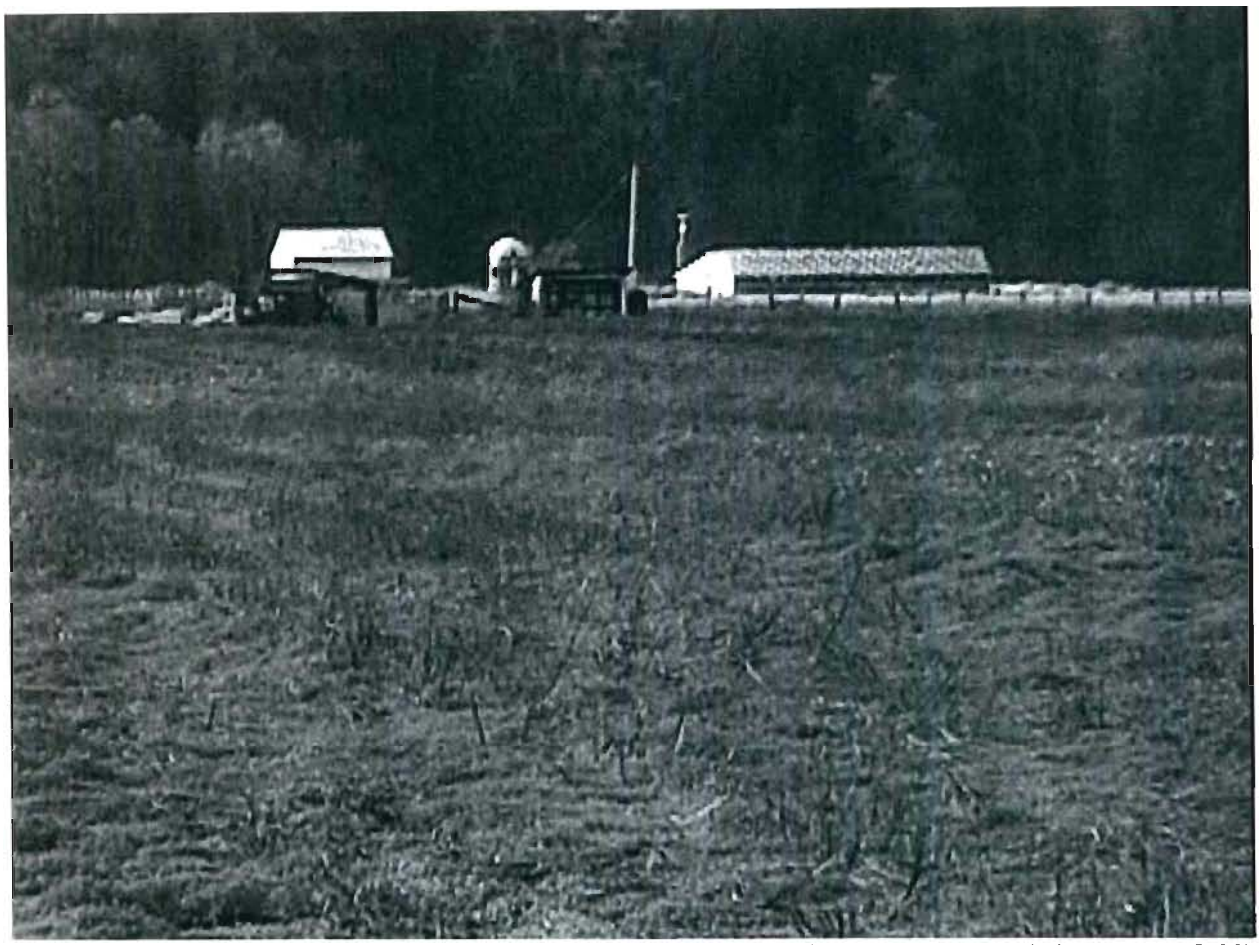
Operations at each WDFW hatchery are governed by a hatchery rearing program. This program specifies the number of each species or stock of fish to be reared, the details of release or transfer to other hatcheries or to citizen groups interested in rearing fish, and the number of eggs from returning adults that must be collected each year to meet production goals. The hatchery rearing program is renewed each year through a Future Brood Document (FBD). The FBD translates management objectives into a guide that is agreed upon by the treaty tribes of Washington and the Fish Management and Hatcheries Programs within WDFW.[37]

WDFW hatchery operations are extensively monitored to ensure that the department's fish health, fish transfer, facility maintenance and support, and genetic health policies are met, with a goal to produce high quality, genetically viable fish populations. Hatchery production and practices must also comply with state and federal environmental protection regulations, and, more recently, the federal Endangered Species Act.[38]

The Hatcheries Program operates 24 complexes (groups of hatcheries) with more than 90 rearing facilities. Complexes include production hatcheries, net pens, acclimation sites and rearing ponds.

- Washington hatcheries produce approximately 75% of all coho and Chinook, and 88% of all steelhead harvested statewide.
- Of all hatchery trout planted, 90% are harvested statewide.
- Approximately 700,000 adult fish (all species) return to hatcheries each year.
- More than 300,000,000 eggs (all species) are collected annually.
- All fish raised in WDFW hatcheries are released into the open waters of Washington. In 1995, 201,000,000 salmon, 8,500,000 steelhead and 22,600,000 trout and warm-water fish were released.[39]

94.1 ⬤ On your right is a sign that indicates you are entering the Thurston County Designated Agricultural Area. County officials and a group of valley farmers have agreed to keep 943 acres of prime farmland off-limits to developers forever. The county will purchase the development rights to the land, which ensures the rolling acreage can be used only for agriculture.[40]



29. FARM IN NISQUALLY VALLEY NEAR MCALLISTER FISH HATCHERY (R. Hixson, 11-23-99)

94.5 Take a left at the "Y". You are now on Nisqually Cutoff Road.

96.1 Go straight at the light. Continue until you come to a "T", turn right and enter Nisqually National Wildlife Refuge.

96.9 Drive to the parking lot by the visitor's center. Pick up a brochure that has a map of the refuge and its trails. The visitor's center has three main exhibits: one which focuses on migratory birds; one on the estuary; and one about the Nisqually watershed, complete with a 3-D model of the watershed.

♦ The exhibits shows that Nisqually National Wildlife Refuge has become an increasingly important place for wildlife, especially migratory birds, as surrounding wildlife habitat is lost to development. For some birds the Nisqually Refuge is a place to feed and rest before moving on, while for others it is the end of their season's journey. Western sandpipers and other shorebirds feed and rest on the estuarine mudflats and marshes. Thousands of ducks and geese find food, water and shelter in the grasslands, mudflats and freshwater ponds during spring and fall migrations.[41]

Spring brings many songbirds; goldfinches, warblers, and tree swallows can be seen in the forests and fields. Woodpeckers, hawks, and small mammals are found in the dense woodlands, croplands, and grasslands, while mixed conifer forests on the bluffs above the delta provide perches for bald eagles and osprey, and a nesting site for a colony of great blue herons. Salmon and steelhead use the estuary for passage to upriver areas.[42]

30. NISQUALLY NATIONAL WILDLIFE REFUGE (R. Hixson 08-19-01)

Nisqually National Wildlife Refuge provides abundant opportunities for wildlife-dependent recreation. Hiking, wildlife observation, wildlife photography, fishing, and environmental education all provide a chance to learn more about the natural world and the importance of places rich in beauty and biological diversity.

The refuge has seven miles of trails including a one-mile loop trail and a 5.5-mile loop trail which provide views of wildlife habitats and access to observation decks, photo blinds, and the Twin Barns Education Center (See Figure 17). Seasonal closures of trails occur throughout the year.

Brown Farm Dike trail is a relic from pioneer days. The shaped earth you walk on is a historic dike that separates seawater from semi-dry land on the delta. Many European settlers viewed wetlands as worthless swamps, breeding grounds for disease and vermin. Others recognized wetlands as valuable real estate, with flat, treeless terrain and fertile soils waiting to be plowed. From either perspective, wetlands throughout Washington have suffered from dredging, draining, and diking operations. More than half of Washington's original wetlands have been destroyed or seriously altered. Only after their disappearance have we recognized their value – as nurseries for juvenile salmon and other aquatic organisms; anchors against shoreline erosion; filters for particles and pollutants; and barriers to flooding.[43]

The Nisqually River watershed's largest wetland was threatened in 1904 when Seattle attorney Alson Brown bought 1,500 acres on the Nisqually River Delta and another 850 acres on the hillside overlooking McAllister Creek. Intent on farming this land, he built four miles of earthen dikes on his property's eastern, western and northern borders, effectively walling off his land from the sea. Wooden one-way gates in the north dike kept out salt water from Puget Sound but let fresh water from upland sources percolate through the property, removing any residual salt with it. After three years of leaching, the salt content of his soil subsided enough for crops to grow on the reclaimed land.[44] By 1914 Brown's farm supplied fresh farm products for the Puget Sound market. The farm had 300 milk cows, 1,200 hogs, 4,000 laying hens and several swarms of honeybees. The waste from the animal pens was deposited directly into the Nisqually River, an act highly detrimental to water quality. Today, under the federal Clean Water Act, farmers must get special permits before allowing contaminated water from large confined animal feedlots to enter rivers or streams.[45]

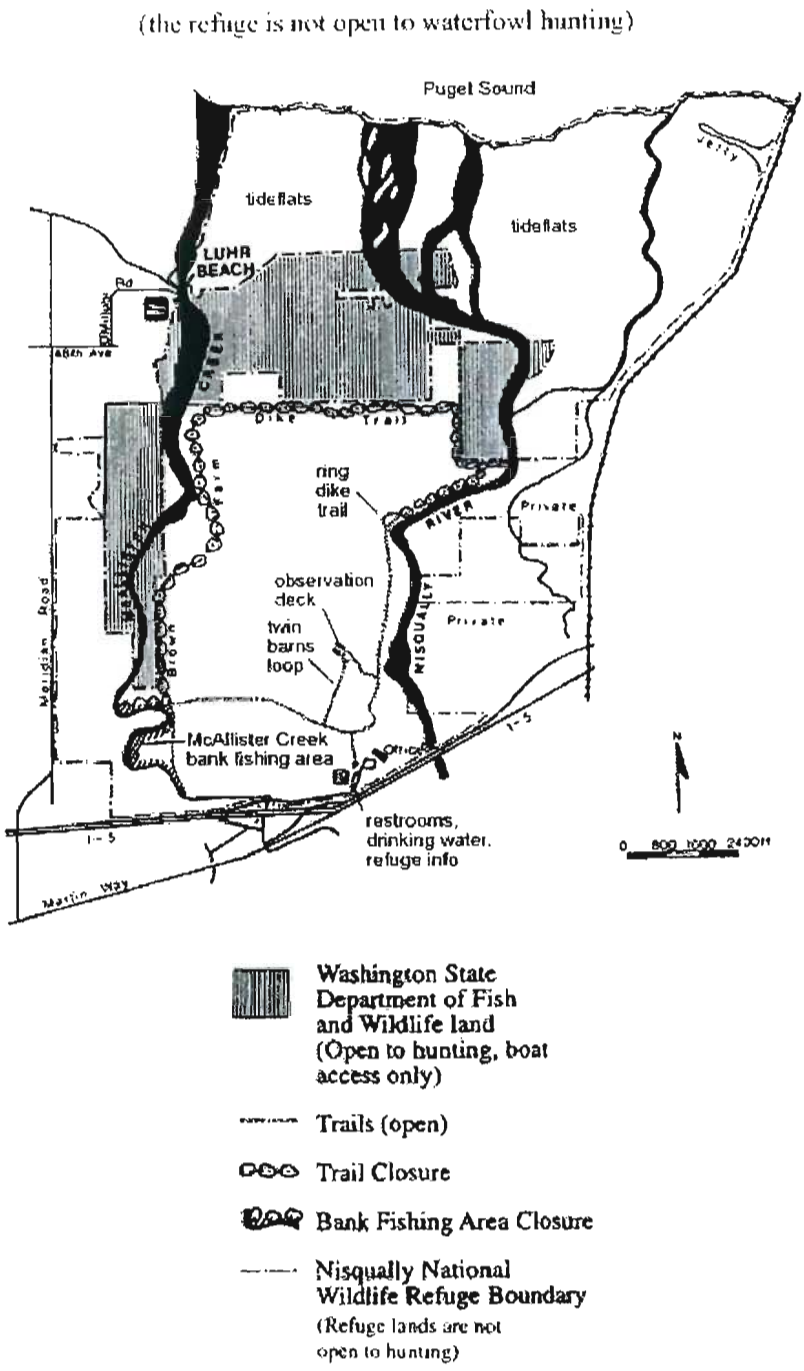


Figure 17. Map of Nisqually Wildlife Refuge.[46]

In the 1960s this land went up for sale and both the cities of Seattle and Tacoma proposed industrial uses for the land. However, local efforts to preserve the delta and its essential feeding and breeding grounds for wildlife prevailed.[47]

In 1969, the State Department of Game bought 620 acres of the delta, effectively limiting development in this area. Two years later, the area outside the farm dike was designated as a National Natural Landmark. Finally in 1974, the U.S. Fish and Wildlife Service purchased the land for the Nisqually National Wildlife Refuge. Lands within the refuge have been set aside especially for wildlife, with public access restricted to trails. As of 1994, the refuge contained approximately 4,100 acres, with about two-thirds under federal ownership.[48]

♦ At the first viewpoint of the Nisqually River along the east side of the Brown Farm Dike trail you can look across the river and see the remnants of the old Brown Farm. Cattle still graze in portions of it today.

31. ON THE BANK OF NISQUALLY RIVER ACROSS FROM BROWN FARM (R. Hixson, 11-23-99)

At this point the Nisqually is not constrained by canyons or hydropower installations. But more subtle influences direct its flow and shape its path. As the Nisqually moves lazily across the lower watershed's plain – a broad, flat expanse filled with reedy marsh plants and pungent estuarine mud—the water in its silt-bottomed main channel is alternately pushed and pulled by Puget Sound's saltwater tides. Strong incoming tides actually push the river back, raising water levels and momentarily reclaiming the Nisqually River's high banks.[49] In 1975 the Nisqually River reclaimed 600 acres when the Brown Farm dike broke. The ring dike was built to hold the tidewater back so the main dike could be repaired. The ring dike trail is only ½ mile long.

In outgoing tides, the Nisqually dumps sand, silt, soil and organic material on either side of its channel and at its mouth. Layer upon layer builds up over the years, and coastal waves change the deposits, continually reshaping the shoreline. This fan-shaped landmass is the Nisqually River Delta.[50] The Delta can be seen at low tide from the observation tower on the north end of the Brown Farm Dike Trail or from Luhr Boat Ramp.

♦ The Delta supports a variety of habitats. Here, the fresh water of the Nisqually River combines with the salt water of Puget Sound to form an estuary rich in nutrients and detritus. These nutrients support a web of sea life. At the edge of the Delta, before the mudflats begin, is the salt marsh. Pickleweed, tufted hairgrass, slough sedge and other salt-tolerant plants dominate this partially submerged turf. Most of these plants grow in tangled masses, their roots aiding in the slow but steady build-up of delta land by capturing silt and soil particles.[51]

On the west side of the Brown Dike Trail you can view McAllister (formerly Medicine) Creek right before it empties into the sea. The Medicine Creek treaty, signed on the banks of this river, gave local tribes the right to fish in their "usual and accustomed places". Although the Nisqually do not depend on wildlife for food now as they did in the past, they still build weirs across rivers to catch salmon that return to the Nisqually River and McAllister Creek.

Together with McAllister and Red Salmon creeks, the Nisqually River forms one of the largest remaining relatively undisturbed estuaries in Washington. Although most major estuaries in Washington have been filled, dredged, or developed, the estuary of the Nisqually River has been set aside especially for wildlife. The McAllister Creek estuary, part of the larger Nisqually River estuary, was created where the creek transports rich sediment downstream while plant and animal matter wash in from the Puget Sound. The resulting mix makes the estuary a very productive area for plants to grow. In fact, the plant material per acre produced here is more than in the best wheat and corn fields.[52]

♦ The delta's seaward edge is known as the Nisqually Flats. In places, the flat's silt and fine-grained sediment is 20 feet deep. Crabs, shrimp, snails, worms and other invertebrate live here along side the geoduck, the largest clam species in North America.[53]

♦ Beyond the flats lies the Nisqually Reach, a broad shoal of mud and sand permanently covered by salt water. The reach can best be seen from Luhr Boat Ramp.

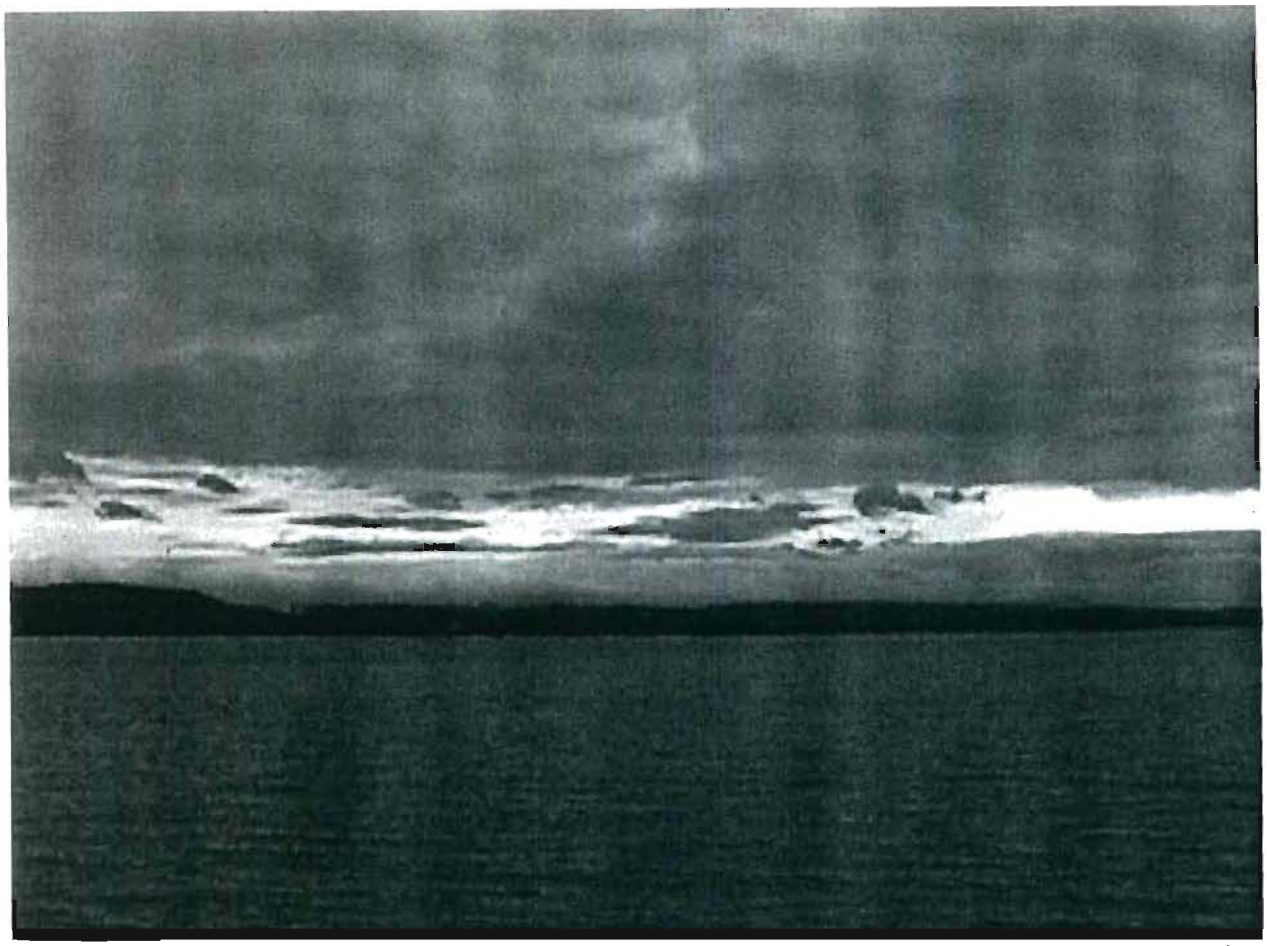
97.6 Return to the Nisqually National Wildlife Refuge entrance. Turn left onto Nisqually Cut-Off Road.

97.8 At the light, turn right onto Martin Way. Continue one mile until Meridian Road.

98.9 At the light, turn right on Meridian Road. Go 2.5 miles until you reach 46th Ave NE.

101.4 Turn right on to 46th Ave NE and go 0.3 miles until you see the sign pointing to the Luhr Boat Ramp.

101.6 Turn left and follow the road to the boat ramp and public fishing area.



32. NISQUALLY REACH (R. Hixson, 11-23-99)

102.1 Park and visit the **Nisqually Reach Nature Center**. The exhibits show the types of birds and animals livuing in the reach and the estuary. After touring the center, walk out on the boat dock. Signs describe the reach and the animals that inhabit it, such as moon snails, mussels, shrimp, zooplankton, crabs, and birds.[54]

♦ From the end of the dock look to your right. Viewed from Puget Sound, Mount Rainier appears to rise from the sea. From here you can see from beginning to end, from the source of Nisqually River water, Mount Rainier, to where the river ends, the Nisqually estuary.

The Nisqually River runs through forest lands, hydroelectric dams, farms, fish hatcheries, parks and towns on its 78-mile course from the summit of Mount Rainier to Puget Sound.[55] The water that pours from the Nisqually River into Puget Sound is laden with everything from grains of sand and soil particles to chemicals, lawn clippings and, after strong storms, tree limbs and other large debris.

The water now at sea eventually returns to the Nisqually Watershed, some as moisture wrung from the clouds atop Mount Rainier. Then, the water's journey through the Nisqually Watershed begins anew.

33. FROM THE SUMMIT TO THE SOUND (R. Hixson, 11-28-99)

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SELECTED ORGANIZATIONS INVOLVED IN THE NISQUALLY WATERSHED:

Mount Rainier National Park, Tahoma Woods-Star Route, Ashford WA 98304
See Section 1.

Nisqually Delta Association, P.O. Box 7444, Olympia WA 98507
They have been active in creating "The Delta Plan" and working toward achieving the goals set in the plan.

Nisqually Indian Tribe, 4820 She-Nah-Num Drive SE, Olympia WA 98513
See Section 3.

Nisqually National Wildlife Refuge, 100 Brown Farm Road NE, Olympia WA 98506
See Section 3.

Nisqually Reach Nature Center, 4949 D'Milluhr Road NE, Olympia WA 98506
See Section 3.

Nisqually River Basin Land Trust, P.O. Box 1148, Yelm WA 98597

Nisqually River Council and its Citizens Advisory Committee, P.O. Box 1076, Yelm, WA 98597
Watershed education has been a high priority of the Nisqually River Council. By forming partnerships with a variety of governmental agencies, the council encourages and funds a variety of projects to inform and involve people in conserving the Nisqually Watershed.

Nisqually River Education Project, P.O. Box 476, Yelm WA 98597
The Nisqually Education Project is a multi-school-district program that develops environmental and cultural curriculum ideas and projects for teachers and students. Funds are used to assist teachers and students in projects directly related to water-quality issues affecting the Nisqually River Basin and salmon habitat. The Nisqually River Project GREEN (Global Rivers Environmental Education Network), part of the Nisqually Education Project, recruits students to help safeguard the Nisqually River and its tributaries. Students collect chemical, physical and biological data on river water each month.

Nisqually River Interpretive Center Foundation, P.O. Box 759, Yelm WA 98597
This organization was formed in 1992 to act on the Nisqually River Management Plan's recommendation for a watershed-wide network of interpretive and educational sites.

Northwest Trek, 11610 Trek Drive E, Eatonville, WA 98328
Opened in 1975, this park has exhibits of Northwest wildlife, walking trails, tram tours and 435 acres forest and meadow where elk, bison, moose and mountain goats roam.

Pioneer Farm Museum, P.O. Box 1520, Eatonville WA 98328
See Section 2.

University of Washington Pack Experimental Forest, 9010 453rd St E, Eatonville WA 98328
See Section 2.